

# ANNALS of SURGERY

A Monthly Review of Surgical Science and Practice

Edited by LEWIS STEPHEN PILCHER, M.D., LL.D., of New York

## ASSOCIATE EDITORS

W. SAMPSON HANDLEY, M.S., M.D., F.R.C.S., of London.

JAMES TAFT PILCHER, B.A., M.D., of New York.

WALTER B. LEE, M.D., of Philadelphia.

Official Publication of the American Surgical Association  
of the New York Surgical Society and the Philadelphia  
Academy of Surgery.

## CONTENTS

TUMORS OF PERIPHERAL NERVES .....	961
DEAN LEWIS, M.D. ....	BALTIMORE, MD.
DERYL HART, M.D. ....	DURHAM, N. C.
PENETRATING TO THE GASSERIAN GANGLION .....	984
J. M. INGER, M.D. ....	MINSK, RUSSIA
CALCIUM CHANGES IN THE BRAIN IN ETHER ANÆSTHESIA .....	993
EDMUND ANDREWS, M.D. ....	CHICAGO, ILL.
WILLIAM F. PETERSEN, M.D. ....	CHICAGO, ILL.
REUREN I. KLEIN, M.D. ....	CHICAGO, ILL.
VALUE OF CORDOTOMY FOR THE RELIEF OF PAIN .....	996
FRANCIS C. GRANT, M.D. ....	PHILADELPHIA, PA.
POST-OPERATIVE PAROTIDITIS: TREATMENT WITHOUT AND WITH RADIUM .....	1007
FRED W. RANKIN, M.D. ....	ROCHESTER, MINN.
BEAN M. PALMER, M.D. ....	ROCHESTER, MINN.
POST-OPERATIVE CORONARY OCCLUSION .....	1014
OSMER S. RANDALL, M.D. ....	KANSAS CITY, KANSAS
THOMAS G. ORR, M.D. ....	KANSAS CITY, KANSAS
LYMPH EXUDATE AND FIBROUS TISSUE .....	1019
EDWARD T. CROSSAN, M.D. ....	PHILADELPHIA, PA.
METASTASIS OF THYROID TISSUE TO ABDOMINAL ORGANS .....	1031
PHILLIP F. SHAPIRO, M.D. ....	CHICAGO, ILL.
TUMORS OF THE WALL OF THE THORAX .....	1043
M. M. ZINNINGER, M.D. ....	PEIPING, CHINA
SARCOMA OF THE BREAST .....	1059
RIGNEY D'AUNOY, M.D. ....	NEW ORLEANS, LA.
ROY W. WRIGHT, M.D. ....	NEW ORLEANS, LA.
RETROPERITONEAL FIBROMYXOMA .....	1067
SAMUEL C. LIND .....	CLEVELAND, OHIO
TETANUS IN NEW ORLEANS .....	1075
AMOS MAVERICK GRAVES, M.D. ....	NEW ORLEANS, LA.
OBSERVATIONS ON THE TREATMENT OF OSTEOMYELITIS BY THE "ORR" METHOD .....	1087
IRVIN E. DEIBERT, M.D. ....	CAMDEN, N. J.
TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY .....	1093, 1099
STATED MEETING HELD MAY 5, 1930. ....	STATED MEETING HELD OCTOBER 6, 1930.
BRIEF COMMUNICATIONS: <i>Bigger</i> : A Muscle-Splitting Incision for Posterior Resection of the Upper Three Ribs. <i>Denneen</i> : Traumatic Inguinal Hernia. <i>Van Alstyne</i> : Persisting Obliterated Omphalo-Enteric Duct with Meckel's Diverticulum as a Cause of Acute Intestinal Obstruction. <i>Webb</i> : Recovery from Fracture of the Neck of the Femur in a Nonagenarian. <i>Stuebner</i> : The Rehfuß Tube in Gastric Surgery. ....	1107
MEMOIRS—HENRY BEECKMAN DELATOUR .....	1117
ALBERT VANDER VEER .....	1119
INDEX .....	1121

J. B. LIPPINCOTT COMPANY, PUBLISHERS

MONTREAL

PHILADELPHIA

LONDON

**In pneumonia**

**Start treatment early**

In the

## **Optochin Base**

treatment of pneumonia every hour lost in beginning treatment is to the disadvantage of the patient. Valuable time may often be saved if the physician will carry a small vial of Optochin Base (powder or tablets) in his bag and thus be prepared to begin treatment immediately upon diagnosis.

*Literature on request*

**MERCK & CO. INC.**

**Rahway, N. J.**

## **TO TURN THE TIDE**

**PARTICULARLY DURING THE WINTER MONTHS  
WITH THEIR RESPIRATORY TROUBLES**

### **Gray's Glycerine Tonic Comp.**

*(Formula Dr. John P. Gray)*

**OFTEN SUPPLIES THE RESERVE REQUIRED**

*Against a Breakdown, or  
To Hasten Convalescence and Recovery,  
without sequelae due to lowered vitality.*

**THE PURDUE FREDERICK COMPANY, 135 Christopher Street, New York, N. Y.**



# ANNALS *of* SURGERY

Vol. XCII

DECEMBER, 1930

No. 6

## TUMORS OF PERIPHERAL NERVES\*

BY DEAN LEWIS, M.D.

OF BALTIMORE, MARYLAND

AND

DERYL HART, M.D.

OF DURHAM, N. C.

THE term neuroma was introduced into medical literature by Odier of Geneva in 1803. The term was applied by him to tumors formed by the diseased enlargements of nerves. William Wood published in the *Transactions* of the Medico-Chirurgical Society of Edinburgh, appearing in 1829, records of some twenty-four cases of neuroma which he had collected from various sources. A clear description of the anatomical and clinical features of these enlargements was given. In this paper Wood cited eight cases in which the tumor had been successfully removed. Some of these are of considerable interest. One appeared in Cheselden's "Anatomy of the Human Body," published in 1773; another in the "Encyclopédie Méthodique de Chirurgie," Paris, 1792, and in this instance an amputation was performed for what was undoubtedly a plexiform neurofibroma of the median nerve in the forearm. Another case was reported in a paper by Sir Everard Home. He describes a case in which he was assisted by John Hunter in the removal of a tumor from the musculocutaneous nerve in the arm. Another case is recorded by Sir Charles Bell, in which he removed a tumor from the internal popliteal nerve. Wood believed that these growths developed from the connective tissue of the nerves and not from nerve substance proper.

A number of articles dealing with neuromas were published during the succeeding years. Smith, of Dublin, in 1849, recognized that neuromas might be of spontaneous origin, or that they might follow division or injury of a peripheral nerve. He gave an exhaustive account of "multiple neuromata," based upon autopsy findings in two remarkable cases. He did not believe, however, that the tumors were composed of nerve tissue. He thought that they developed from the connective tissue. Sarcomas of nerves were not mentioned in these early publications.

With the introduction of new histological methods and improvements in histological technic, a new classification of neuromas appeared. Heretofore, the term neuroma had been applied rather indiscriminately to tumors of different kinds and to a number of lesions affecting nerves which were probably not tumors. The histology of nerve fibres had advanced considerably

\* Read before the American Surgical Association, May 16, 1930.

when Virchow, in 1863, gave a classification of these tumors based upon a structural instead of a clinical basis. He divided these tumors first into the true and false. The true neuroma was defined as a tumor which was composed for the most part of newly formed nerve tissue. The false neuroma was thought to be composed of connective tissue derived from the sheaths of the nerve. He divided true neuromas into three groups—the neuroma gangliocellulare, composed of newly formed nerve cells; the neuroma fibrillare amyelinicum, composed mostly of non-medullated nerve fibres; and the neuroma fibrillare myelinicum, composed chiefly of medullated nerve fibres. Virchow thought that many of the cases of neurofibromas were in reality true neuromas, composed of non-medullated nerve fibres. Nerve fibres might, however, easily be mistaken for connective tissue fibres, if special staining methods were not employed. He also suggested that a true neuroma might be converted into a fibroma, if pressure caused disappearance of the nerve fibres. The histological structure of these tumors revealed by the use of specific stains, indicates that many of Virchow's contentions as to the structure of these tumors can no longer be maintained.

In the Laboratory of Surgical Pathology of the Johns Hopkins Hospital are over 180 tumors which are classified as fibromyxomas or fibromyxosarcomas of peripheral nerves. About forty of these tumors were placed in the sarcoma group. The sections of the tumors were restudied. The typical benign tumors, showing in places the palisade arrangement of the nuclei and in other areas the reticular structure (to be discussed in more detail later), could be easily picked out. The tumors occurring in von Recklinghausen's disease and sarcomas arising from nerves could not be so easily distinguished. All the histories were then reviewed. In some the data were incomplete; in many there was no positive evidence that the tumor was connected with a nerve. It should be noted that the connection of the typical benign tumor with a nerve could be easily demonstrated. All the sarcomata included in this paper had a definite origin from or connection with a nerve.

Thirty-seven cases of proven peripheral nerve tumors were available for study. These are classified as follows:

Neurinomas (with palisade arrangement of the nuclei and reticular structure) . . . . .	11	Von Recklinghausen's disease without tumors of deep nerves . . . . .	5
Benign tumors (sections lost; diagnosis made from history and original pathological notes) . . . . .	4	Von Recklinghausen's disease with deep nerve tumors, malignant 4, benign 7 . . . . .	11
Sarcomas . . . . .	3	Localized cutaneous neurofibromatosis . . . . .	1
		Tumor in neck, one showing ganglion cells . . . . .	2

*Benign Solitary Tumors, Neurinomas, Perineurial Fibroblastoma (fourteen solid, one cystic).*—All of the solid tumors occurred in adults, the ages of the patients ranging from twenty-eight to sixty-five years, the average

## TUMORS OF PERIPHERAL NERVES

being forty-four. They were equally distributed between males and females. The duration of the tumor before removal by operation in the twelve cases in which it was recorded ranged from six months to ten years, with an average duration of three and one-half years.

The distribution according to nerves is as follows:

Median .....	3	Cutaneous branch of posterior ti-	
Radial .....	2	bial .....	1
Sciatic .....	2	Branch of intercostal nerve ....	2
Posterior tibial .....	2	Lesser internal cutaneous .....	1
Cutaneous branch of external pop-		External popliteal .....	1
liteal .....	1		

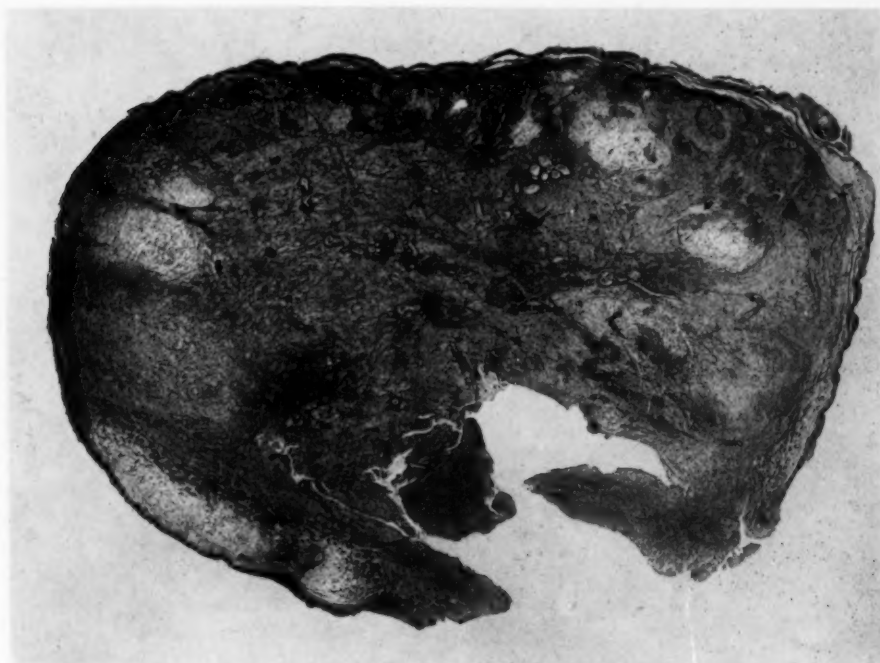


FIG. 1.—Solitary tumor (neurinoma, perineurial fibroblastoma) removed from the left median nerve in the lower part of the axilla. Capsule of tumor is broken at one point. In the middle part of the upper portion are islands of type A tissue. The greater part of the tumor is made up of type B, reticular tissue. Myxomatous changes have occurred in the tumor.

The three following histories will be cited to indicate the clinical characteristics of the benign group of tumors. These three cases are selected as they are typical.

CASE I.—Mrs. S. G., aged fifty-four years, was admitted to the Johns Hopkins Hospital, January 26, 1928. A year before admission she first noticed a shooting pain down the outer surface of the left arm. She did not pay much attention to this at first. It became more severe. Five months before admission a small, tender swelling was noted under the left arm just below the anterior axillary fold. When pressure was made upon this nodule pain radiated into the forearm and hand along the distribution of the



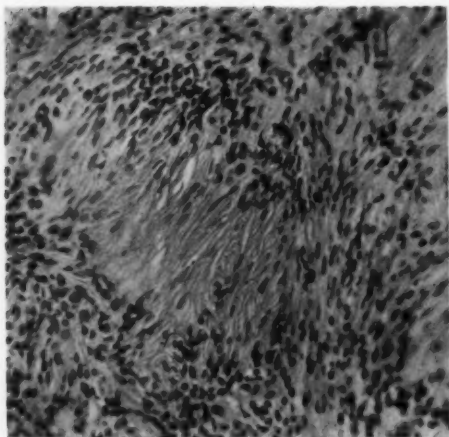


FIG. 2.—High power of a section of preceding tumor showing typical palisade arrangement of the nuclei. This arrangement is characteristic of this type of tumor of nerve trunks. It should be remembered that a similar histological picture may be found in a rapidly growing myoma.

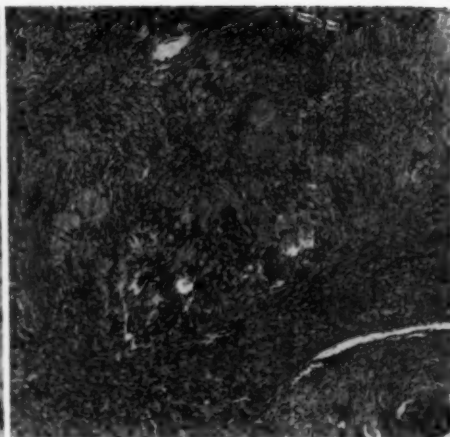


FIG. 3.—High power of a section made from a tumor arising from the dorsal root of a spinal nerve, showing the typical histological picture of type A tissue found in neurinoma (perineurial fibroblastoma).

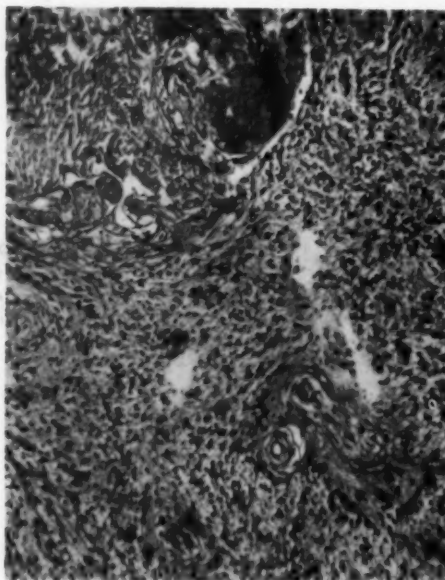


FIG. 4.—High power of a section through a solitary tumor removed from the left popliteal nerve. This tumor had a myxomatous appearance. Some funiculi were resected in removing this tumor, the major part of which could be enucleated. This tumor was composed almost entirely of type B, the loose reticular tissue, with a tendency to myxomatous changes, described by Verocay.

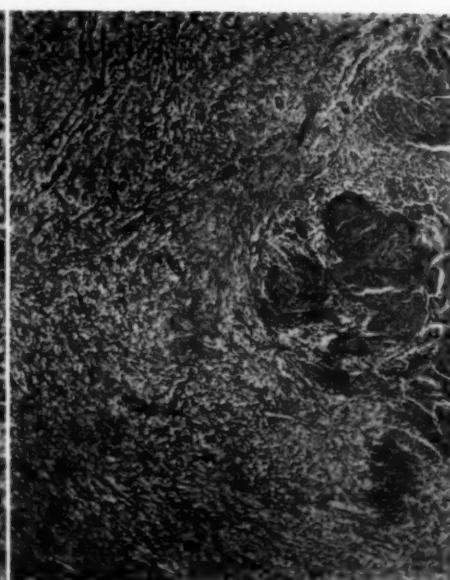


FIG. 5.—High power of a section of large tumor removed from the sciatic nerve. Resection of the nerve was necessary because several funiculi passed through the tumor. This is the only one of fifteen solitary tumors which required resection. End-to-end suture performed. No recurrence after almost two years. Considerable return of function. Whorls of type A tissue with palisade arrangement of nuclei are interspersed among reticular type B tissue.

## TUMORS OF PERIPHERAL NERVES

median nerve. There has been no numbness, tingling or weakness of the parts to which the pain has radiated.

On January 27, 1928, under local anaesthesia, the trunks of the brachial plexus were exposed and the nerves blocked. A small tumor was found in the median nerve. The sheath of the nerve was split and a tumor as large as a large hazelnut was shelled out. The tumor could be removed without sacrificing any nerve fibres. The sheath of the nerve was then sutured with fine silk.

This patient has fully recovered. For a while she complained of some peculiar sensory disturbances over the course of the median nerve. These have disappeared and there have been no evidences of return of the tumor. The histology of the tumor, which grossly had a myxomatous appearance, will be discussed later.

CASE II.—M. C., colored, female, aged forty-three years, was admitted to the hospital March 29, 1930. She complained of a lump in her left thigh posteriorly about the middle. She also complained of pain which radiated to the knee and into the foot. Her symptoms dated from April, 1922, and began four months after an operation for a "tumor of the stomach" when she accidentally discovered the lump referred to above. The lump has not increased in size since its discovery. Several weeks ago, while in bed, she experienced suddenly sensations of pins and needles in her left foot. This was followed by aching pains in the sole of the foot, big toe and knee. The pains were not increased by standing and walking. They occurred chiefly at night. Some tenderness is noted over the lower pole of the tumor.

On examination a circumscribed, deeply located tumor is found on the posterior side of the left thigh at the junction of the middle and lower thirds. Pressure upon this causes pain to run down the patient's leg over the distribution of the great sciatic nerve. No impairment of the functions of the leg and foot is observed. Sensation is preserved.

April 3, 1928, the tumor was exposed and the sciatic nerve mobilized. An attempt was made to enucleate the tumor, but the fibres of the sciatic nerve were incorporated in it and a resection of the nerve was necessary. An end-to-end suture was performed. The knee had to be flexed at a right angle in order that the nerve suture could be performed. A plaster-of-Paris case was then applied. The leg was gradually extended to its normal position after eight weeks.

The tumor was about the size of a hen's egg. Grossly it had a myxomatous appearance. The funiculi of the nerve were so closely related to the tumor that enucleation was impossible.

This patient was examined July 10, 1930. There has been a marked improvement in function. Plantar flexion is relatively strong. There is some dorsal flexion. The patient walks without the aid of a cane, and although there is some foot drop the toe of the shoe is no longer scraped.



FIG. 6.—The tumor described in FIG. 5 may be seen forming a prominence on the posterior surface of the thigh about the middle.

CASE III.—C. D., white male, aged sixty-three years. The patient first noticed a mass in the back of the left thigh three years ago. Two years ago pain, which ran down the left leg into the foot, particularly to the dorsum of the foot at the base of the great toe, was noted. This pain has become decidedly worse and more persistent. It is now constant, but varies in intensity. There is no difficulty in walking, and walking does not make the pain more intense. The left leg seems to be colder than the right. The patient complains considerably of the cold sensation and wears an extra sock to counteract it.



FIG. 7.—Sarcoma of the sciatic nerve. Exceedingly rapid growth. Metastatic nodules have formed along the course of the nerve and extended toward the pelvis. Thigh amputation after attempt to cure by resecting the sciatic nerve.



FIG. 8.—Tumor of the sciatic nerve and its branches. Small nodules may be seen in the branches of the nerve below the site of the original tumor.

A small, ill-defined mass is found in the left buttock near the gluteal crease. This measures about three centimetres in diameter. Another mass is found in the upper part of the popliteal space along the course of the great sciatic nerve. This is not attached to the skin. It is deeply situated, and it is difficult to outline the tumor accurately. Sensation is not interfered with and there is no loss of motor function.

October 10, 1929, the left sciatic nerve was explored under local anaesthesia. The incision was above the site of the tumor, which was not located. A definite localized fatty mass was removed. The symptoms persisted. When the patient was in the right position the mass could be located, and on December 13, 1929, another operation was



## TUMORS OF PERIPHERAL NERVES

performed. This was begun under local anaesthesia, but had to be continued with gas. The tumor was exposed and the internal popliteal nerve mobilized. The tumor was apparently encapsulated. The nerve was split. Most of the tumor could be enucleated. Some funiculi were so closely attached to the capsule that they had to be sacrificed. These funiculi happened to be sensory. The patient has some anaesthesia on the back of the leg.

This tumor resembled the other two in gross appearance. It was myxomatous. Throughout the solid parts of the tumor were small cysts. Scattered throughout the tumor were small yellowish areas.

The three tumors just described are typical of the remaining twelve of the benign group, and the other histories and microscopic findings will not be discussed. They belong to a group of tumors to which Verocay has given the name of neurinoma. These tumors clinically are benign. Some have undoubtedly been classified as sarcomas or fibromyxosarcomas. Because of areas of localized nuclear richness they have been regarded as resembling histologically tumors arising in other tissues which run a malignant course. Verocay first recognized the nature of these tumors and believed that they were composed of tissue which had some relation to the sheath of Schwann. The neurinomatous tissue is of two types. Type A is characterized by a palisade arrangement of the nuclei. The tissue is decidedly polar in arrangement and appears in long bundles or strands. The so-called nuclear rows of Verocay appear only in type A tissue. They are quite characteristic. The nuclear arrangement with polarization reaches its highest expression in neurinomas, and may be considered characteristic of them. This type may be relatively abundant in some tumors; in others there may be but little. In some there may be none of this type. Transitions between types A and B are found, type B having apparently differentiated from type A. There is a tendency for hyaline degeneration to occur in the intercellular substance of the type B tissue. This degeneration occurs in this type only, and sometimes to a high degree. It gives to it the glistening appearance and transparency of connective tissue hyaline. This tissue is, as a rule, softer than that of even a soft fibroma. If smaller or larger masses of the hyaline material fuse and swell, cyst-like structures are formed, which displace neighboring tissue and lead to a thickening of the same, which form a capsule about the tumor. Types A and B occur together in many of these tumors. The transitions between the two may be gradual. In some instances they are sharply demarcated from each other. In other tumors type A tissue occurs in sharply delimited islands scattered throughout the reticular type B tissue. Type B tissue is found in all tumors, while type A is absent relatively often. The whorls and vortices of type A may be preserved in type B, but are made up of a different tissue.

The histological structure of these tumors is well illustrated by the tumors which were removed from the three cases cited.

Fig. 1 is a photograph of a cross-section of the tumor removed from Case I. The capsule of the tumor has been broken at one place. Along the middle of the upper

border of the tumor is an area of solid tissue occurring in islands, some of which are more or less fused. This is type A tissue. The greater part of this tumor is made up of the reticular type B tissue in which changes had occurred, giving rise to the myxomatous appearance of the tumor.

Fig. 2 is a photomicrograph through the tissue at the middle of the upper border of the tumor. The palisade arrangement of the nuclei and the polar arrangement of the fibrils are well shown in this section.

Fig. 3 is a photomicrograph of a section through the tumor of the sciatic nerve described under Case II. Islands of type A tissue with the palisade arrangement of the nuclei may be seen. These are surrounded by type B tissue, in which the changes giving rise to tissue of a myxomatous appearance occur.

Fig. 5 illustrates the vortices and whorls of type A tissue in a tumor removed from the sciatic nerve. The palisade arrangement of the nuclei is well shown in this section. Transformation of this into type B may occur, but when this occurs the whorl and vortices arrangement is preserved.

The same tissue is found in spinal-cord and spinal-nerve tumors. It is also found in dural endotheliomas and acoustic tumors. A palisade arrangement of the nuclei and tissue resembling the type A is found also in some myomas and myosarcomas.

As already stated, Verocay was the first to suggest that these tumors were composed of a tissue which had some relation to the sheath cells, and gave to them the name neurinomas. Penfield has remarked that the term neurinoma—applied to the solitary nerve tumor—has been unfortunately widely accepted. The term conveys a definite meaning and will probably remain in the literature. Although there may continue to be discussion as to the tissue involved, the term conveys a very definite meaning. The presence of this tissue in both solitary tumors and the tumors of von Recklinghausen's disease led Verocay to assume that the tumor develops from the sheath cells. These tumors do not arise from the sheath cell, which is of ectodermal origin, but from connective tissue sheath about the fibrillæ.

Fifteen solitary tumors of peripheral nerves compose this group. Fourteen have been enucleated from the nerve. In one case the sciatic nerve had to be resected. On gross examination they appeared myxomatous. These are benign tumors, as none has recurred. They have a definite histological structure and belong to the neurinoma or perineurial fibroblastoma group. The nearer the periphery the tumor is located, the more the type B tissue predominates over the type A.

*Von Recklinghausen's Disease (Neurofibromatosis).*—It should be remembered that patients with this disease do not come to the hospital for treatment until the superficial tumors are large enough to cause disability or disfigurement, or until the involvement of deep nerves gives rise to symptoms. A few of the patients under consideration were admitted for other conditions. One patient came to the hospital to have all the skin tumors, numbering 118, removed. The group considered in this paper must be regarded as representing the late rather than the early stages of von Recklinghausen's disease.

There are sixteen cases in this group. The ages range from four to fifty-six years. The small skin tumors and pigmented areas dated from birth

## TUMORS OF PERIPHERAL NERVES

or childhood in the eleven cases in which a note was made as to duration. Frequently the tumors reached a certain size and then ceased to grow. Other tumors continued to appear either as new developments or as the result of growth of minute nodules which had not been discovered previously. The superficial tumors, as a rule, were widely distributed over the trunk, head and extremities. Three of the patients with superficial tumors, without evidence of deep lesions, requested operation because of the size of one or more tumors. One patient entered the hospital for the excision of all the visible nodules. A tumor was removed for histological study from a patient on the



FIG. 9.—Von Recklinghausen's disease with multiple subcutaneous nodules and a lobulated mass over the right eye.



FIG. 10.—Von Recklinghausen's disease. Multiple nodules in the skin with pigmentation of skin and a pendulous tumor of the chest wall.

obstetrical service. In some instances the superficial tumors were scattered indiscriminately over the body. In a number of cases, however, there was a linear arrangement along the superficial nerves, usually a symmetrical distribution. Pigmentation of the skin was mentioned seven times, but it was undoubtedly present in other cases. The areas of pigmentation varied in size from a few to as many as six to eight square millimetres. These areas were scattered irregularly over the body and extremities.

In this group of sixteen cases there were five without and eleven with deep nerve tumors.

The following are examples of neurofibromatosis in which the deeper



nerves are not involved. These cases are not uncommon, and the histories of but three cases will be given.

E. S., colored female, aged twenty-six years, states that she had tumors of the skin as long as she can remember. She has had paræsthesia of the extremities and has been unable to walk since having a hernia repaired several weeks ago under spinal anæsthesia. Pigmentation of the skin is marked. She thinks that more nodules have appeared in the skin over the chest during the past week.

On examination numerous subcutaneous and deeper nodules of varying size, which are soft, freely movable and not tender, are found scattered over the body. The distribution of these nodules does not correspond to nerve distribution. There are pigmented areas upon the back. The patient has mental symptoms and quite severe psychic disturbances. A skin tumor was removed for diagnosis. The diagnosis was neurofibroma (von Recklinghausen's disease).

E. C., white female, aged fifty-six years. This patient has had tumors in the skin of



FIG. 11.—Von Recklinghausen's disease with tumors on deep nerves. These have a symmetrical distribution. The prominence on the posterior part of the arm is caused by a tumor on the radial nerve. This tumor was enucleated, the fibres of the nerve remaining intact.



FIG. 12.—Tumor removed from the median nerve of the patient represented in FIG. 11. This tumor was enucleated. It had a myxomatous appearance on cross-section.

the face and chest as long as she can remember. There are also pigmented areas in the skin which are most marked in the skin of the right upper extremity. A pedunculated tumor the size of an orange hangs from the mid-line of the chest down over the abdominal wall. The base of the pedicle is the size of a half dollar. The pedicle is at least six inches in length. The dependent part of the tumor is ulcerated and anæsthetic. Sensation is present over the base of the tumor. The remaining tumors have appeared at various times, although many were present at birth.

April 27, 1926, the large pedunculated tumor, measuring twenty-seven centimetres in length, was removed by Doctor Cohn. A wide margin of skin and subcutaneous fat was removed with the tumor. On section the tumor was firm, hard and fibrous beneath the ulcer. In other parts it was soft and vascular. The microscopic examinations revealed a fibromyxoma with areas so vascular that the possibility of a hæmangioma was considered.

N. W., white male, aged twenty-six years. Seven years before admission to the hospital the patient had had a growth removed from above the right eye. Two months

## TUMORS OF PERIPHERAL NERVES

after removal the tumor developed again. Five years before a growth had been removed from the right foot and from the chest. Since childhood he had noticed numerous soft, painless nodules over the surface of the body. These, with the exception of the large one which was excised, have given him no trouble.

The patient has the typical appearance of von Recklinghausen's disease. Numerous soft tumors lying in or just beneath the skin are found. July 10, 1920, Dr. Mont Reid removed tumors from the forehead and cheek. The diagnosis of pigmented neurofibromas was made.

The three cases cited above are typical of von Recklinghausen's disease. It is interesting to note the pathological diagnosis which has been made, for not infrequently the myxomatous character of the tumor has been emphasized. In one the vessels were prominent enough to suggest a vascular tumor. The superficial group of tumors has developed from cutaneous nerves.

There are eleven cases in which tumors have been found upon the deep nerves. In four of these malignant changes occurred. Malignant changes in tumors situated upon deep nerves are not at all uncommon in these cases. Garré, in 1890, directed attention to the tendency for such tumors to become malignant.

G. B., white male, aged twenty-eight years. The patient was first admitted to the medical service in August, 1920. He had tumors distributed over the entire body which had been present since early childhood. The tumor behind his right ear was noted by his mother when he was one year old. New tumors have appeared from time to time. These tumors are circumscribed, grow for a time, become stationary, but do not disappear. They are not painful or tender. In 1918 a tumor behind the right ear was excised and a tumor on the left leg was partially removed. The patient was admitted to the hospital again August 8, 1926, when a small tumor on the left side of the chest was removed. Histologically this tumor was like those found in von Recklinghausen's disease. Recently there has been some stiffness of the left knee and disturbance of function of the left leg. These are due to a large pedunculated tumor which has been present for fifteen years, but recently has grown larger and now hangs down over the knee. Numerous small tumors are scattered over the body. A large boggy tumor mass is found on the anterior aspect of the left thigh which extends from a little below Poupart's ligament to below the knee. The overlying skin is soft and elastic. Palpation of the tumor suggests a fluid wave. The patella is located in this mass of tissue.

October 4, 1926, at operation a large cavity was found in the tumor which communicated with the joint. When this was opened about 800 cubic centimetres of fluid were evacuated. A specimen was taken for examination. The tumor seemed to infiltrate the muscle and was not removed. The patient returned to the hospital again in January, 1929. A large mass had developed in the left half of the pelvis just above Poupart's ligament. On examination a large, hard mass is found in the pelvis and the left lower quadrant of the abdomen. This extends from Poupart's ligament to the umbilicus and causes the abdominal wall to protrude. This tumor is firmly fixed, rises from the pelvis and extends over to the mid-line. The tumor of the left thigh is much smaller than when the patient was here before. January 19, 1929, a biopsy was performed. Part of the tumor was excised without opening the peritoneal cavity. This tumor was firm and fibrous in character.

A diagnosis of spindle-cell sarcoma was made. The patient has been receiving radium treatments. When seen in Baltimore several months after the biopsy the tumor was of about the same size as when the tissue was removed.

E. H., white female, aged fifty years. This patient was operated upon December 1, 1922. Since childhood she had complained of a drawing pain in the left leg and thigh.

## LEWIS AND HART

She had worn red flannels to relieve this. The leg has been massaged for relief of this pain. Curious pigmented spots and blotches are found over the abdomen and extremities. Since childhood numerous painless, somewhat firm, subcutaneous nodules have been noted over the body. These have increased but slightly in size, and at the present time measure from two to six millimetres in diameter. The pains in her left leg have been more severe during the last ten years. About six years ago she noted that her left hip seemed slightly larger than her right. For the last year she has noticed a definite growth. This tumor was operated upon one year before admission to the hospital and found to be attached to the sciatic nerve. It could not be entirely removed. Since that time it has grown rapidly in spite of radium treatment. The pain has been so severe that narcotics have been required. Hearing in the right ear is

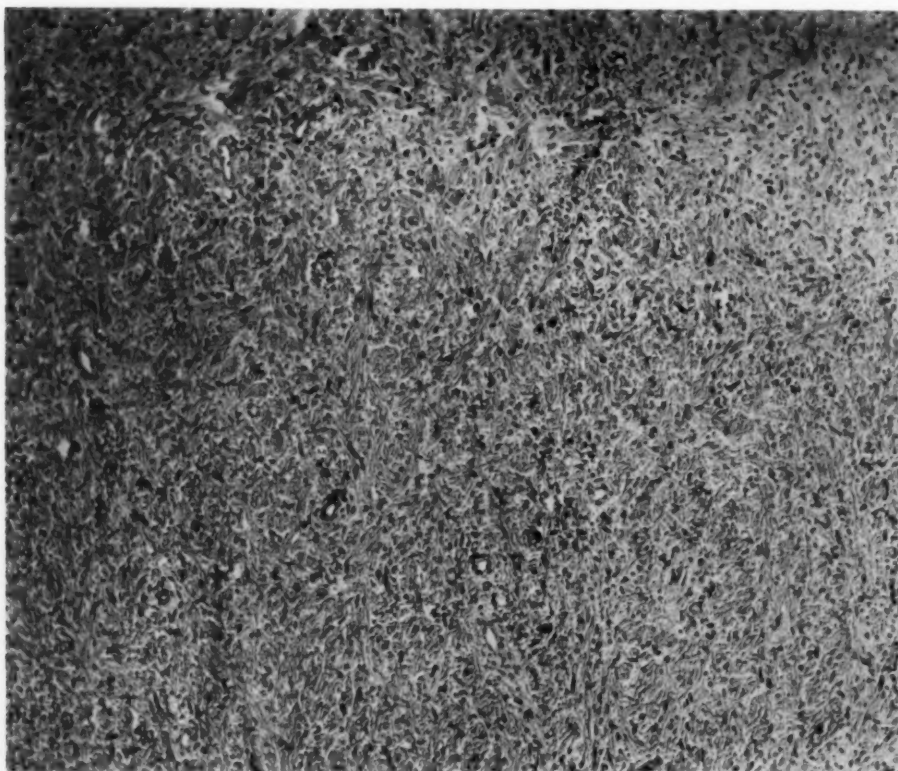


FIG. 13.—Histological preparation of the tumor shown in FIG. 12. This tumor is mixed, containing bands of fibrous tissue. Scattered between these are islands of reticular tissue (type B). These tumors have a decided tendency to undergo malignant (sarcomatous) changes.

impaired and at times the patient complains of numbness of the right side of the face. The patient has evidently lost weight recently. The tumor on the left thigh is about the size of a football, measuring twenty-four by eighteen centimetres. Over this is a scar twenty centimetres long. There is no muscular weakness in the left leg. The skin over the body has a mottled appearance. The pigmented areas, varying in size from a pinhead to a silver dollar, are irregularly distributed. The possibility of a tumor on the eighth nerve was considered because of the impairment of hearing.

December 1, 1922, the tumor in the thigh was removed. It apparently rose from the great sciatic nerve. Only a partial removal was possible. When the tumor was cut across it had a lobulated, yellowish, pearl-gray appearance. The patient was a poor operative risk and died a few hours after the operation.



## TUMORS OF PERIPHERAL NERVES

*Pathological diagnosis.*—Spindle-cell sarcoma with extensive necrosis and degeneration. Malignant degeneration of a tumor in von Recklinghausen's disease.

The following are cases of von Recklinghausen's disease with tumors of deep nerves without malignant changes. The specimens which were removed illustrate especially well the histology of these growths and how they differ from that of the solitary tumor.

E. R., white male, aged twenty-one years, was admitted to the Johns Hopkins Hospital October 10, 1927. The patient has small tumors scattered over the body, most of which correspond to the course of superficial nerves. He came to the hospital especially because of symptoms associated with a tumor over the course of the left musculospiral nerve, located where the nerve is in the radial groove. Numerous well-circumscribed tumors of various sizes, from a small shot up to a small orange, are scattered over the body. The greater number of nodules are about the size of a pecan. Practically all are superficial, firm and rubbery in consistency, and, in general, follow the course of superficial nerves. In the left arm along the course of the radial nerve in the radial groove is a fusiform tumor, constricted at the middle. Pressure on this causes a tingling sensation over the distribution of the radial nerve. Pigmented areas are scattered over the body.

At operation, October 10, 1927, a tumor was found upon the radial nerve. The tumor was removed by splitting the nerve, the fibres of which seemed to form a capsule about it. The tumor was shelled out of the nerve. The pathological diagnosis was neurofibroma. The patient returned in March, 1930, with a large tumor on the median nerve of the right side just below the axilla. This tumor was removed by separating the fibres of the nerve and shelling it out. This tumor was more myxomatous in character than the tumor previously removed from the musculospiral nerve. Neither tumor has recurred. It should be remembered, however, but a short time has elapsed since their removal.

The following cases, which might be included under the term Ranken neurom, have been characterized by multiple growths upon the nerves of an extremity associated with an increase in size of all the tissues of the extremity.

R. R. is a female child, aged four years. About sixteen months before operation, September 28, 1928, a general eruption resembling insect bites appeared upon the body. This eruption appeared from time to time. It was noticed then that the left leg and thigh were larger than the right. The enlargement involved the leg, thigh and half of the pelvis on the left side. Thirteen months before admission small, tender, subcutaneous nodules appeared about the upper end of the fibula. The child has not complained of pain, but she favors the right leg somewhat. The nodules have increased somewhat in size. The left lower extremity is distinctly larger than the right and has none of the changes associated with a lymphædema. The hypertrophy involves all the tissues from the gluteal muscles to the tips of the toes. Muscle power is not reduced. There is no limitation of motion, no spasticity nor pain. There is some eversion of the left foot. Near the left knee and ankle both medially and laterally there are firm, discrete masses which have a linear distribution and are apparently connected with nerves. These are especially well marked posterior to the medial malleolus. All the other parts of the body are normal.

Some of the nodules along the posterior tibial nerve were removed for study. A pathological diagnosis of neurofibroma was made.

The following case has been reported by Dr. Willis Campbell:

## LEWIS AND HART

A. E., a white child, aged fourteen years, has the following history. When the patient was one and a half years old the mother noted that the right ankle and foot were larger than the left. Shortly after that it was noted that the entire extremity was larger. This relative difference in size has been maintained. Examination shows a healthy girl of fourteen with no abnormality except in the right lower extremity. This extremity is enlarged, being increased in length and circumference. Deformity at both the knee- and ankle-joints is noted. The patient walks with difficulty as the weight is transmitted onto the dorsum of a club-foot. The extremity has many diffuse, lobulated

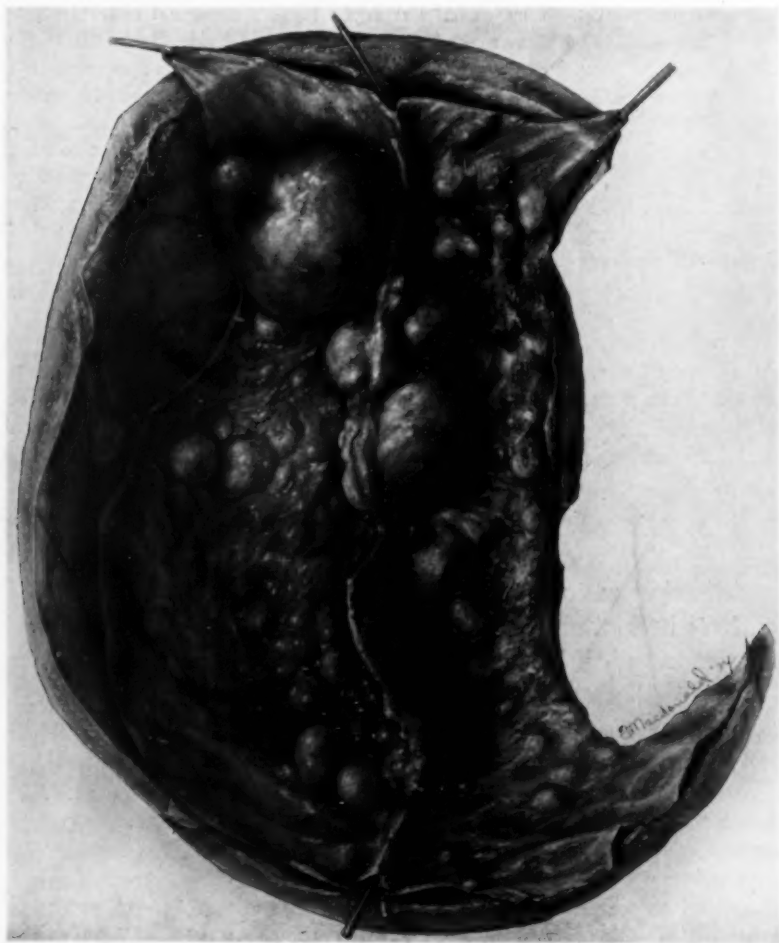


FIG. 14.—Von Recklinghausen's disease. Multiple tumors arising from the dura (Dandy).

tumors beneath the deep fascia which are differentiated with difficulty from the muscles. These cylindrical masses are from one to two inches in diameter. These masses are tender. Measurements show that the right thigh is four inches larger than the left, and the right calf three inches larger than the left. The right lower extremity is five and a half inches longer than the left. Muscle power in the right leg is not impaired. X-ray of the right lower extremity shows that the bones are increased in length, decreased in diameter and atrophic.

Doctor Campbell, by repeated operations, removed numerous lobulated tumors. The

## TUMORS OF PERIPHERAL NERVES

leg was considerably diminished in size. The femur was shortened and the ankle stabilized by removing the astragalus. The lower epiphysis of the tibia and fibula were destroyed, as it was thought that abnormal growth from other parts would counter-balance the effect of epiphyseal destruction. After four operations on the soft parts and two on the skeleton the extremities were of equal length, but the right leg was greater in diameter than the left by one inch.

The pathological report is as follows: The section shows loose tissue composed of strands with few nuclei. There is much homogeneous material which resembles coagulated lymph between the cells. One pathologist reported that he identified nerves in the growth.

These six cases represent different clinical manifestations of the same disease: the cutaneous form of von Recklinghausen's disease, a form associated with tumors upon the deep nerves in which there is a decided tendency for sarcomatous degeneration of the tumor, and a form localized to an extremity which becomes enlarged and to which the term of elephantiasis nervorum might properly be applied, although this term has been applied to other lesions of this type other than the two last described.

*Elephantiasis Nervorum.*—Bruns, in 1891, published an article upon Rankenneurom in which he states that this tumor is one of the rarest and most peculiar. Two of the first cases were observed by Depaul, in 1857, and Guersant, in 1859. These were carefully studied by Verneuil. Two were reported by Billroth, in 1863 and 1869. Bruns states that the greatest interest attaches to the origin of these tumors and their relation to other nerve tumors. According to him this is a form of congenital elephantiasis; if by this term is understood a congenital anlage leading to tumor-like connective-tissue growths which may affect skin and subcutaneous tissues, sometimes the blood-vessels, the lymphatic vessels and nerves (elephantiasis telangiectodes, lymphangiectodes, neuromatodes). Bruns grouped under the term elephantiasis nervorum—generalized neurofibromatosis—the cases in which the tumor involved a limited area of distribution of the nerve (Rankenneurom), and those cases in which the changes involved the ends of the cutaneous nerve (fibromata mollusca). The localized forms differ in extent, not in nature, from the generalized.

Garré has pointed out the tendency of tumors in neurofibromatosis to become malignant. Malignant degeneration occurs in at least 12 per cent. In the cases reported by us, although the series is too small to permit of definite conclusions, malignant degeneration has occurred in 50 per cent. There are many transitions between the benign and malignant growth, so that it is difficult to determine at times where benignancy ends and malignancy begins. In Garré's case ciliated epithelium was found, suggesting a teratoma. This brings up the question of possible development of these cells from the sheath of Schwann. Cohn has reported epithelial tumors in peripheral nerves which probably have developed from the sheath cell.

Trauma and operative interference may predispose to malignant changes, and the possibility of such a change occurring after partial removal of one of these growths should always be considered. This group of connective tissue

growths differs from the group of benign tumors first described, in which there is little, if any, tendency to malignant changes. Virchow recognized the tumors occurring in von Recklinghausen's disease as due to an overgrowth of connective tissue. Wood, Smith and von Recklinghausen also recognized the connective tissue origin of these tumors. Penfield states that a pure neuromfibroma in one sense is not a neoplasm at all. There are wandering nerve fibres derived from the involved nerve and a surrounding tangle of

reactionary connective tissue which is a magnification of the widespread alteration of the nerves in this systemic disease. Confusion arises from the fact that at times within these neurofibromata, perineurial fibroblastomata may appear and may grow so large as to displace most of the neurofibroma tissue to the periphery. In the case of von Recklinghausen's disease, however, nerve fibres will be found to enter each tumor, with few exceptions; while in the solitary perineurial fibroblastoma



FIG. 15.—Elephantiasis nervorum. The left lower extremity is enlarged. Multiple nodules can be palpated over the nerves. These are especially marked over the short saphenous nerve.



FIG. 16.—These tumors were removed from the posterior tibial nerve just behind the internal malleolus in patient represented in Fig. 15.

mata, the comparatively normal nerve is invariably applied to the capsule of the tumor without penetrating it.

This last statement is undoubtedly subject to exceptions, for, if it were so, all neurinomas could be enucleated. In one of our cases, a typical neurinoma, resection of the sciatic nerve was necessary because the tumor was penetrated by funiculi, and in another some fibres of the internal popliteal had to be sacrificed.



## TUMORS OF PERIPHERAL NERVES

In the neurofibromas of von Recklinghausen's disease the tissue is mixed. This can be seen readily in studying sections. Many of the tumors may be pure fibromas. In the multiple neurofibromas the neurinomatous tissue is the loose, delicate, reticular type (type B). The centrally located tumors occurring in von Recklinghausen's disease may be composed entirely of neurinomatous tissue. This accounts for the relative frequency with which central degenerative changes occur in these.

The solitary tumor and the multiple tumor of von Recklinghausen's disease differ histologically. Clinically, we are justified in concluding that there is a great difference as regards the possibility of malignancy between the solitary tumor and the multiple tumor of neurofibromatosis. There is also a great difference in the histology. A peripheral nerve is a complicated structure composed of highly differentiated epithelial and connective tissue elements, which in their growth may give rise to specific and characteristic structures. The sheath of Schwann may, in tumor formation, give rise to a growth distinctly epithelial in character. This change probably accounts for the epithelial tumors in peripheral nerves recently reported by Cohn, and the ciliated epithelium observed by Garré in a malignant tumor occurring in von Recklinghausen's disease.

*Sarcomas.*—In this group are four tumors. The histories of these will be given. Two illustrate the mode of extension of a sarcoma, and one the possibility of at least a long period of freedom from recurrence following operation.

T. M., white male, aged fifteen years, noticed pain December 15, 1928, just above the knee along the hamstring muscles. A tumor about the diameter of a twenty-five-cent piece appeared later in the region where the pain was first experienced. The tumor was aspirated but nothing was obtained. An operation, the nature of which cannot be ascertained, was performed March 14, 1929. The patient remained in the hospital two weeks. Since then the patient has complained of numbness of the leg. An examination made upon June 7, 1929, showed that the right leg was flexed at the knee. A long scar is noted on the posterior surface of the thigh. The right thigh is larger than the left, and in the region of the scar over the posterior part of the right thigh is a movable mass. It is impossible to say whether this is the original tumor or a recurrence. An X-ray examination revealed a large, soft-part tumor which extended along the course of the sciatic nerve well up into the gluteal region. There were no evidences of metastases in the chest.

Doctor Bloodgood believed that the tumor developed from the sciatic nerve and that an amputation of the thigh should be performed.

The tumor was adherent to the muscles, quite myxomatous and œdematous. Small tumors were found on the branches of the sciatic nerve. Some of the tumor mass extended beyond the sciatic notch, rendering complete removal impossible.

The branches of the sciatic nerve below the popliteal space were covered with white, smooth, myxomatous masses. The large, and probably the original, tumor has many necrotic, hæmorrhagic areas. The pathological diagnosis was fibromyxosarcoma of the sciatic nerve.

The second case illustrates again the tendency of a sarcoma to extend along the nerve.

M. M., white male, aged forty-one years, noted in 1910 a hard nodule in the lower lip. This did not ulcerate. It was enucleated. Since this first enucleation the tumor

has recurred and has been removed fifteen times. The last operation was performed in June, 1915. No ulcer had formed. The cervical lymph nodes had not been removed. X-ray treatments had been given at various times for five years.

A histological study of the tissues which had been removed at previous operations revealed a cellular tumor composed of spindle and round cells. In some sections nerve tissue was found in the tumor. The tumor was thought to be multiple neurofibroma.

September 10, 1915, Doctor Bloodgood removed the lower jaw and submaxillary glands. The inferior dental was as large as a thumb. The tumor extended up to the point at which the nerve emerges from the skull. This point was cauterized. Histological examination revealed much the same picture as that of the tissue previously removed. The cells were, however, larger and more irregular in size.

The patient died January 26, 1916, with cerebral symptoms, apparently due to an

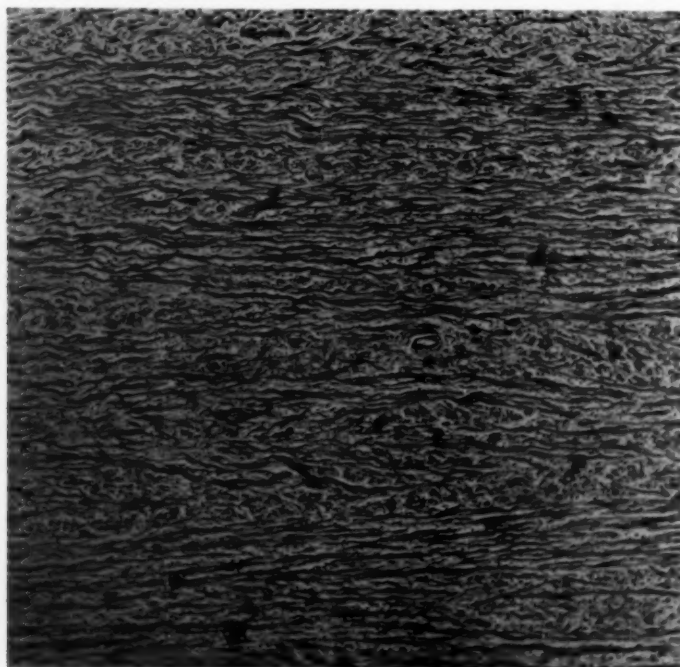


FIG. 17.—Histological preparation of the tumors shown in Fig. 16. The histology differs markedly from that of the solitary tumor (neurinoma) of peripheral nerves.

extension of the growth to the cranial cavity. This tumor, regarded at one time as a multiple neurofibroma, was undoubtedly malignant, as indicated by the number of recurrences in the lip and final extension to the skull.

A third sarcoma involved the internal popliteal nerve on the left side. The nerve was resected. Seven months after operation there was a recurrence, and a little over five years after the first operation the patient died. A diagnosis of round-cell sarcoma was made.

Dr. Miles F. Porter has kindly furnished us with the history of a case in which a tumor developed in the upper third of the thigh posteriorly in a female patient aged fifty-two years. This tumor caused pain which radiated down to the ankle and up to the hip. A tumor was removed in August, 1923. Six months later another tumor was removed. This was situated a few inches above the original tumor. Seven months later the tumor recurred and was removed again. During one and three-quarter years this tumor recurred frequently.

## TUMORS OF PERIPHERAL NERVES

On July 2, 1923, Doctor Porter operated and removed an encapsulated tumor the size of a small orange from the muscles on the posterior surface of the thigh. A diagnosis of sarcoma was made from frozen sections. The bed of the tumor was cauterized (actual cautery) and alcohol applied to the wound surface.

Subsequently, after many recurrences the sciatic nerve with a tumor was resected and a fascial tubulization performed. Five years later the patient reported that there had been no recurrence of the tumor. Some foot drop persisted and there were sensory changes associated with resection of the sciatic nerve. It is impossible to determine the origin of this tumor, but eventually it involved the sciatic nerve, necessitating its resection. It may have arisen primarily in one of the branches of the sciatic, and secondarily have invaded the main trunk.

Sarcomas of peripheral nerves, as already stated, are extremely malignant and tend to form metastases along the nerve primarily involved. They may, however, extend to other nerves in the extremity, passing to these apparently along branches communicating with the nerves primarily involved.

Two rather unusual tumors were encountered in this series, one arising apparently from the cervical sympathetic, the other from the vagus.

*Tumor of the Cervical Sympathetic.*—G. N., white male, aged forty-one years, had a small mass on the left side, about the middle of the neck, for eighteen years. At first this was about the size of a cherry. It gradually increased in size, but it has not increased in size any more rapidly of late. There has been no pain. There has been no difficulty in swallowing until recently, when there is a slight sensation of pressure on swallowing and occasionally on breathing.

Examination reveals a tumor on the left side of the neck. It is elliptical and fills practically the entire space between the angle of the jaw and the clavicle. It has displaced the trachea and the carotid artery to the right side. The carotid artery has been displaced so far forward and to the right that it can be seen beating almost in the midline of the neck. There is no difference in the pupils on either side. They react normally to light and accommodation.

This tumor could be easily removed. The carotid artery was in front and median to the tumor, the jugular vein and the vagus nerve were in front and to the outside. The most probable origin of this tumor seemed to be the cervical sympathetic trunk. The tumor had little vascular supply and was easily separated from the surrounding structures. The histology of this tumor is represented in Fig. 19. As will be seen, the tumor contains a large number of ganglion cells.

*Tumor of the Right Vagus Nerve.*—The other tumor in this group arose from the right vagus nerve. Because of the pigmented areas in the skin it is quite possible that this tumor belongs to the von Recklinghausen group. There were no other palpable tumors in this case.

The patient, a white male, was nineteen years old. Five years ago he noticed for the first time a small mass behind the right mandible. This caused no pain. Four years ago the mass became larger, and a doctor advised that the tonsils be removed. Later a diagnosis of tuberculous glands was made.

Examination reveals a mass on the right side of the neck. It fills the space between the angle of the jaw and the mastoid, and occupies the upper half of the neck posteriorly. The tumor is the size of a man's fist. The skin over it is freely movable. The surface of the tumor is smooth, with no signs of lobulation. It is sharply delimited from the other structures in the neck. The common carotid artery is anterior to the tumor. The trachea is displaced to the left. There are no pupillary changes which would suggest connection with the cervical sympathetic.

The tumor is apparently fixed by neighboring structures. Von Recklinghausen's disease, a brachial cyst, and carotid body tumor were considered in the differential

diagnosis. This tumor when removed was found to be a fibromyxoma of the vagus nerve. Following removal of the tumor the patient was unable to swallow anything but soft foods and liquids. He strangled when he attempted to swallow. The symptoms which he complained of following operation were due to loss of function of the right superior and recurrent laryngeal nerves.

This case, in view of the marked pigmentation, should probably be regarded as an example of von Recklinghausen's disease. The only palpable tumor developed upon the right vagus nerve. The patient with the tumor of the cervical sympathetic died one year and four months after operation. There was a local recurrence and pulmonary metastases. It has been impossible to trace the patient with the tumor of the vagus. He returned to the hospital six months after having been discharged, and to that time the signs and symptoms associated with paralysis of the vagus persisted.



FIG. 18A.—Tumor on the sciatic nerve in a case of von Recklinghausen's disease.

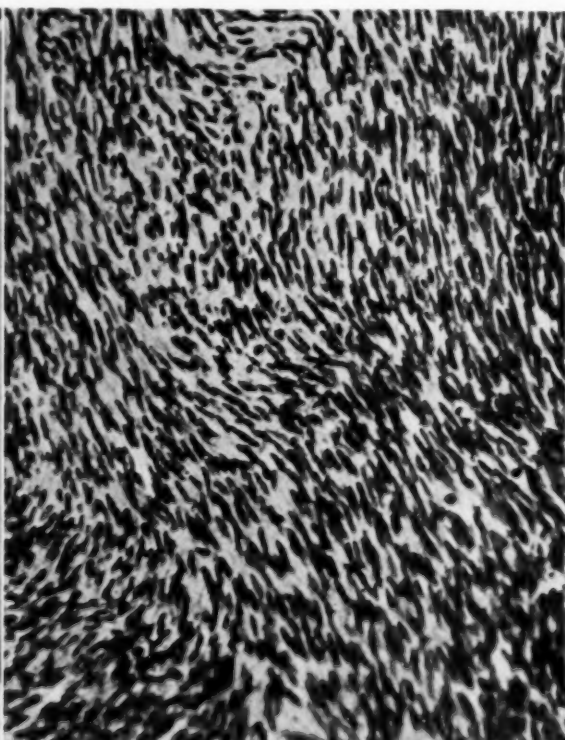


FIG. 18B.—Histological preparation of a recurrent tumor in the patient shown in Fig. 18A. Malignant change in a tumor of von Recklinghausen's disease.

*Neurofibromatosis Confined to the Skin, Localized in Extent (Fibroma Molluscum).*—R. L., white male, aged twenty years, was operated upon April 10, 1907. The patient stated that since birth a small tumor had been present on the internal surface of the right foot just below the malleolus. This has gradually increased in size, and other tumors have appeared on the internal portion of the plantar surface of the foot. When the patient was thirteen years old the tumors were excised, but in about six weeks others developed. These have increased in number and size until at the present time the entire internal part of the plantar surface of the right foot and great toe are covered with tumors.

On the inner side of the sole of the right foot and great toe are peculiar, pedunculated, soft tumors which are more or less separated from each other. They, however, lie side by side and seem to be almost continuous. They are flattened out by the pres-



## TUMORS OF PERIPHERAL NERVES

sure exerted when the patient is standing. In gross appearance they look very much like fibromata mollusca but do not seem to follow the distribution of any one nerve.

On April 10, 1907, the tumors on the inner side of the plantar surface of the foot were excised, as little skin of the pedicle as possible being removed. The skin was brought together with interrupted sutures of fine silk except in two places, which were allowed to granulate. Eleven years after this the patient reported that there had been no recurrence of these tumors.

The clinical manifestations of different varieties of peripheral nerve tumors have been discussed. An attempt will be made to correlate clinical manifestations and prognosis with histological findings. A peripheral nerve has a complicated structure, being composed of neurofibrillæ, the myelin sheath, the sheath of Schwann and connective tissues surrounding the fibres, funiculi, and nerve. Judging from a study of the tumors in this series and from cases which have been reported, the neurofibrillæ take no part in tumor formation.

Fifteen solitary tumors of peripheral nerves have been described. These have not recurred following operation, and in all but one case the tumor could be enucleated. In one case a large tumor of the sciatic nerve was found. This could not be enucleated because the nerve fibres ran through it. Almost two years after resection and suture there has been no recurrence of the tumor.

These tumors are composed of the neurinomatous tissue described by Verocay. They contain islands or whorls of type A tissue, which is characterized by nuclear palisades. They resemble histologically the acoustic tumor and the tumors developing upon spinal nerve roots, most frequently upon the posterior roots. Degenerative changes, occurring most often in the reticular tissue, may cause the myxomatous appearance of the tumor which is so common.

Lhermitte and others have recently suggested that these tumors characterized by palisading of the nuclei developed from the sheath of Schwann cells, the lemmocyte, and classified them as gliomata. Verocay was the first to suggest such an origin. Penfield states that the fibres produced in these neoplasms show that the type cell bears no relation to neuroglia nor to the ectodermal sheath of Schwann. The histological picture is characterized by palisading and parallelism of the nuclei and a tendency to form nuclear eddies and streams. The fibres are typically long, slender, wire-like, and arranged parallel to each other. These fibres resemble the connective tissue seen in normal nerves where they run parallel to nerve fibres. The term perineurial fibroblastoma has been given to these tumors by Mallory. Clinically they are benign tumors which, as a rule, can be enucleated from the nerve, leaving the greater part of it intact.

The tumors occurring in von Recklinghausen's disease were described by Verocay as mixed. They were shown by him to be composed of neurinomatous tissue and connective tissue. The nearer the periphery the tumor is located, the more the fibrous tissue predominates. The tumors occurring in von Recklinghausen's disease frequently undergo secondary changes. Such

changes are indicated in the tumor represented in Fig. 18B. This tumor had a decidedly myxomatous character. These tumors are apt to undergo sarcomatous changes. This tendency has been frequently noted, and in the series herein reported, though small, malignant changes occurred in 50 per cent. of the cases. Penfield states that in retaining for the tumors of von Recklinghausen's disease the time-honored name of neurofibroma, the term must be understood to signify a tumor which contains both nerve fibres and connective tissue. It is not a new growth of nervous tissue, although there are nerve fibres and apparently new nerve collaterals running in it. It is not

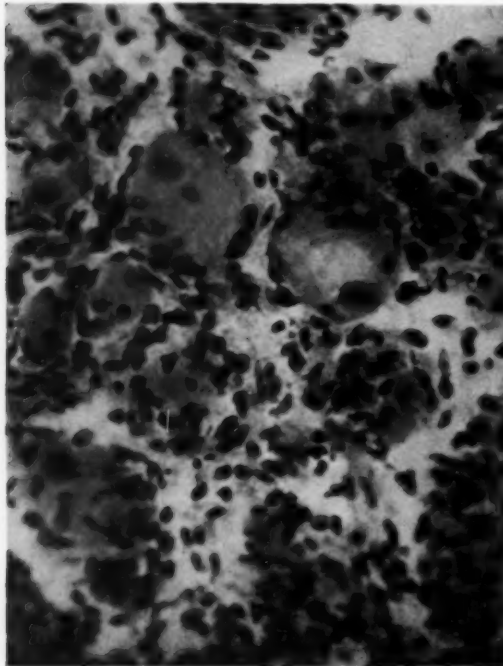


FIG. 19.—Histological preparation of tumor developing from the cervical sympathetic, containing ganglion cells. This tumor was malignant. It recurred locally within a few months after removal, and formed metastatic growths in the lungs.

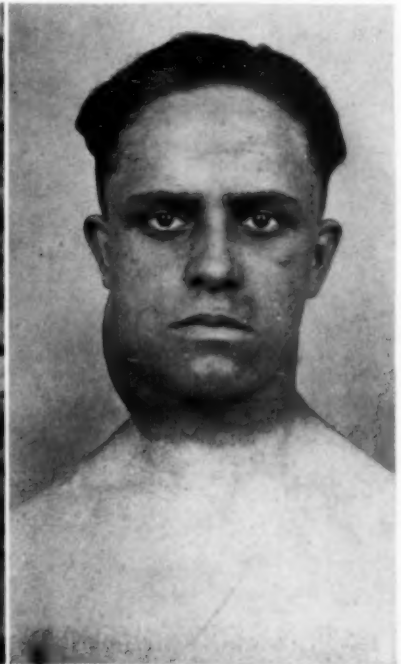


FIG. 20.—Neurofibroma of the right vagus nerve. Diagnosis of this tumor was suggested by pigmentation of the skin. No other tumors palpable on deep nerves. Paralysis of fibres of the vagus followed removal of the tumor.

a simple fibroma but a connective tissue reaction that is part of a more general process.

In the tumors situated peripherally the neurinomatous or fibroblastomatous tissue may be suppressed by an overgrowth of fibrous tissue, a fibroma then being found. Whether the masses occurring upon the nerves in von Recklinghausen's disease should be regarded as tumors or merely as a connective tissue reaction to an irritant may be a disputed question. Clinically, they appear as tumors with a decided tendency to undergo sarcomatous changes.

These growths may be confined to the nerves of an extremity. All the tissues of such an extremity may be affected, resulting in a decided increase

## TUMORS OF PERIPHERAL NERVES

in length and circumference unaccompanied by pigmentation of the skin or any appearance suggestive of a lobulated elephantiasis.

The one case of a tumor developing from the cervical sympathetic is of interest because of the relatively early recurrence of the tumor and the formation of metastases to the lung.

### BIBLIOGRAPHY

- Antoni, N.: Ueber Rückenmarkstumoren und Neurofibrome. Stockholm, 1920.
- Bruns, P.: Ueber das Rankenneurom. Beitr. z. klin. Chir., vol. viii, p. 1, 1891-1892.
- Cohn, I.: Epithelial Neoplasms of Peripheral and Cranial Nerves. Arch. Surg., vol. xvii, p. 117, 1928.
- Garré, C.: Ueber sekundär maligne Neurome. Beitr. z. klin. Chir., vol. ix, p. 465, 1892.
- Penfield, W.: The Encapsulated Tumors of the Nervous System. Surg., Gynec., and Obstet., vol. xlv, p. 178, 1927.
- Roussy, G., Lhermitte, J., and Cornil, L.: Essai de classification des tumeurs cérébrales. Ann. d'anat. path. méd.-chir., Paris, vol. i, p. 333, 1924.
- Smith, R. W.: A Treatise on the Pathology, Diagnosis and Treatment of Neuroma. Dublin, 1849.
- Thomson, A.: On Neuroma and Neuro-Fibromatosis. Edinburgh, 1900.
- Verocay, J.: Multiple Geschwülste als Systemerkrankung am nervösen Apparate. Festschrift f. Chiari, p. 378, Vienna, 1908.
- Idem*: Zur Kenntnis der "Neurofibrome." Beitr. z. path. Anat., vol. xlviii, p. 1, 1910.
- Virchow, R.: Die Krankhaften Geschwülste, vol. iii, p. 233, Berlin, 1863.
- Von Recklinghausen, F.: Ueber die multiplen Fibrome der Haut und ihre Beziehung zu den multiplen Neuromen. Berlin, 1882.
- Wood, W.: Painful Subcutaneous Tubercle. Med.-Chir. Trans., Edinburgh, vol. iii (part 2), pp. 317, 640, 1829.
- Idem*: Observations on Neuroma. Med.-Chir. Trans., Edinburgh, vol. iii (part 2), p. 367, 1829.

## PENETRATING TO THE GASSERIAN GANGLION\*

By J. M. IRGER, M.D.

OF MINSK, RUSSIA

FROM THE SURGICAL CLINIC OF PROF. S. M. RUBASHOW, OF THE STATE UNIVERSITY OF WHITE RUSSIA, S.S.S.R.

AS INTRODUCTION, a short review of the methods concerning this matter may serve. The method of Härtel-Schlösser enables one to reach as well into the third branch of the trigeminus nerve as into the Gasserian ganglion. His method consists in penetrating with the needle between the ascending branch of the lower jaw and the protuberance of the upper jaw into the oval orifice and the Gasserian ganglion. In using Härtel's method, the surgeon sits down in front of the patient, with the needle in his right hand; he pricks, after the necessary anæsthesia, the skin of the cheek on the level of the second upper molar tooth, and he introduces the forefinger of the left hand into the mouth of the patient in order to prevent the possibility of penetrating with the needle into the cavity of the mouth. The needle is ten centimetres long and 0.8 millimetre thick.

First of all, putting the "bar" of the needle at a six-centimetre distance from the point, one advances the latter upward and backward into the fossa infratemporalis in such a manner as to penetrate into the interspace of the ascending branch of the lower jaw and the protuberance of the upper jaw. If the surgeon faces the patient from the front, the direction of the needle has to coincide with the pupil of the corresponding side; if looked at from the side, the prolonged axis of the needle has to point to the articular tubercle of the temporal bone. After the needle has passed six centimetres in depth, that is, as far as the oval orifice, the "bar" has to be advanced at one and one-half centimetres; that is, the distance necessary to let pass the needle from the oval orifice to the Gasserian ganglion. As soon as the needle-point has reached the oval orifice, a pain will be felt by the patient in the region innervated by the third branch. While introducing the needle-point into the ganglion the surgeon injects very slowly the medicated solution, whereafter complete anæsthesia sets in.

Härtel observed that the oval orifice presents a canal the axis of which coincides with that of the fore-plane of the pyramid of the temporal bone; the axis is continued between the ascending branch of the lower and the protuberance of the upper jaw and crosses the second upper molar tooth. In some cases, the axis has so changed that it crosses not the second but the first or the third molar tooth. Sometimes it occurs that the needle-point introduced on the level of the second molar does not reach the oval orifice. That depends on the height of the upper jaw. In such cases the surgeon has to introduce the needle before or behind the second molar tooth.

---

\* Read before the Russian Surgical Congress, 1929.



## PENETRATING TO THE GASSERIAN GANGLION

In some cases, the axis of the oval orifice will not coincide with that of the pyramid of the temporal bone. In this case the needle will penetrate into the temporal part of the brain instead of the Gasserian ganglion.

In the literature there have been described cases of purulent meningitis when the needle was introduced following Härtel's method. Probably this was occasioned by technical failure.

With regard to their neighborhood the following vessels can be injured: art. carotis int., art. mening. media, bulbus ven. jugularis, and sometimes also the art. maxill. int. Härtel, experimenting on many cadavers, in some cases pricked the fossa jugularis; in some cases, too, the eustachian tube.

The size of the oval orifice is of absolute importance for reaching into the Gasserian ganglion. Härtel, after measuring, fixed the length of the former at five to eleven millimetres, and the width of it at two to seven and one-half millimetres. If the width is less than three millimetres, Härtel, considers it as impossible to penetrate into the ganglion. Härtel, after measuring fifty-eight skulls, found that the distance between the oval orifice and the upper margin of the pyramid of the temporal bone varies between nineteen and twenty-three millimetres, the minimal distance being fourteen millimetres. Thus, he proposed, after penetrating into the oval orifice, to advance the needle not higher than at fifteen millimetres, in order to avoid a possible penetration of the needle-point into the cisterna pontis and a wounding of the upper sinus petrosus. Härtel advises, too, to follow the movements of the eyes and the pupils during the injection for prevention of a possible influence of the alcohol on the oculomotorius and abducens nerves of the eye-muscles. The injection must be stopped as soon as dilatation of the pupils and deranged abduction of the eyes are visible. Not seldom after injections into the Gasserian ganglion, keratitis has been noticed.

POLOZOF noticed this complication in the case of a broad oval orifice, whereby the needle was able to easily glide into the skull; anæsthesia of all the three branches of the trigeminus nerve supervened.

Many authors have observed that the eustachian tube was damaged—the alcohol had penetrated into the throat. MALKIN has described a case when the patient lost his hearing and sight from injecting alcohol after the method of Härtel. NEUGEBAUER mentioned a case of wounding the carotis interna. In the latter case the alcohol had been injected in spite of blood aspiration by the needle-point, and amaurosis supervened.

PUSSEN has not noticed a severe wounding of the vessels in the case of delivering the injection into the nerve trunks or the ganglion: by using a slender needle it does not pierce the vessels, and, even if piercing did occur, the wounding would be of the least degree.

To be sure that the needle-point has attained the Gasserian ganglion, first of all one has to administrate an injection—that of one cubic centimetre of a 4 per cent. novocaine-suprarenin solution—and only after the anæsthesia has supervened, is it allowed to inject one-half to one cubic centimetre of 90 per cent. alcohol.

LEXER, BROWN, and other authors, in most of the cases administered the injection under a general narcosis on account of the increased sensibility of the skull base in case of trigeminal neuralgia and the necessity of operating on the patient when he is in a state of absolute patience and calm. KULEN-KAMPF advises to administer the injection while the surgeon is still not tired; he administered the whole injection in fifteen to twenty minutes.

Sometimes, during the injection of novocaine into the Gasserian ganglion, it reached the subarachnoidal space, provoking somnolence, headache, and vomiting. The alcohol injection is sometimes complicated by cyanosis, slowing of the pulse-rate and headache.

Most authors insist upon the necessity of administering the alcohol injection in a hospital.

Härtel fixed the following indications of treating the trigeminal neuralgia by alcohol injections:

1. Recent cases of neuralgia of the fifth pair have to be treated by purgatives and hot-air apparatus after the method of Bier and especially by massage. Peripheric and central novocaine injections are successful too.

2. Chronic cases with localization in single branches should be treated by peripheric alcohol injections after the method of Schlösser or by injections into the skull base.

3. Severe and relapsed cases after peripheric injections must be treated by intracranial injections into the Gasserian ganglion. These injections must be repeated till a permanent anæsthesia has supervened.

4. Resection of the Gasserian ganglion is indicated in cases of failure in spite of repeated intracranial injections, and in those, when frequently undertaken punctures of the oval foramen do not succeed on account of anatomical conditions.

5. Peripheric and central alcohol injections are indicated in cases of repeated neuralgias caused by inoperable tumors.

Härtel himself considers his method as a technically difficult one, demanding careful exercises on the cadavers.

All the above-mentioned data demonstrate that penetration into the Gasserian ganglion after the method of Härtel is a serious operation.

OFFERHAUS, too, in 1910, proposed a method of reaching the Gasserian ganglion. It consists essentially in introducing the needle, bent to a  $130^{\circ}$  angle, behind the last molar tooth, near the hamulus pterygoideus; then the needle has to be advanced along the median plane of the lateral plate of the pterygoid apophysis to the oval orifice. Not mentioning infection, which this method could always involve, there is the inconvenience of the contortion of "hamuli pterygoidei" and the irregularity of form of the lateral plate of the pterygoid apophysis, which may hinder the penetrating into the Gasserian ganglion.

The method of penetrating into the Gasserian ganglion through the foramen rotundum is not popular on account of its technical difficulty.

The method of Harris consists essentially in penetrating into the oval

## PENETRATING TO THE GASSERIAN GANGLION

orifice through the incisura mandibularis. One introduces the needle in a horizontal direction on a line joining the incisura intertragica of the ear conch with the nose wing in a three-centimetre distance before the incision. In some cases the needle strikes against the ascending branch of the lower jaw. In order to avoid that, one has to drop a bit the outward end of the needle, after which the latter passes easily through the incision of the lower jaw on the lowest level of it. Directed a little backwards, the needle strikes at a three-centimetre depth against the lower plane of the large wing of the sphenoid bone; advanced thereafter in the depth of a four to four and one-half-centimetre distance from the skin, the needle reaches the third branch of the trigeminus nerve. This method must be considered as an inconvenient one, because following one introduces the needle blindly without corresponding measuring. Besides, following this method we cannot change as we like the directions of the needle for it traverses the firm fascia and muscles and we risk wounding the art. mening. med., and art. maxill. int. After this method, even if the needle reaches into the oval orifice, when advanced, it must wound the cavernous sinus.

ROMANZEW described five cases of alcohol injections into the Gasserian ganglion after the method of Meyer. With a head-side position of the patient, one introduces the needle through the incision of the lower jaw perpendicularly into the depth. After one has passed the adipose tissue clothing the internal upper jaw artery and external pterygoid muscle, one reaches the external plate of the pterygoid apophysis of the sphenoid bone. Just behind the angle formed by the free margin of the plate with the base of the skull, nearly on the same level as that of the plate, is the oval orifice. While the mouth of the patient is tightly closed, one introduces the needle along the back margin of the top of the coronoid apophysis of the lower jaw which is to be found previously, then one advances the needle along this margin vertically into the depth, closely hugging the back margin of the plate. Gliding on the latter one manages to direct the needle a little backward, until the contact with the bone is lost, after which we turn the point of the needle towards the skull base and advance it one to two centimetres deeper in. The needle strikes against the internal margin of the oval orifice, where the fluid may be injected.

The above-described method is a modification of that of Harris. The inconvenience of this method as well as that of Harris is, as mentioned, the danger of wounding the upper jaw artery and the impossibility previously of fixing the depth of the puncture.

In opposition to the method of Härtel, we are penetrating into the Gasserian ganglion from below, *i.e.*, inwardly from the angle of the lower jaw.

OFFERHAUS remarked in his day that the oval orifices and the articular tubercles were on a same line. Uniting by direct lines the angle of the lower jaw, the upper margin of the articular tubercle, and the oval orifice, we get an *isosceles* triangle with the top at the angle of the lower jaw. Consequently, the distance from the angle of the lower jaw to the oval orifice,

will be equal to the distance from the former to the upper margin of the articular tubercle. The examination of fifty skulls has enabled us to affirm that our deductions are quite true. Now, as it is quite easy to determine in everyone the distance from the angle of the lower jaw to the upper margin of the articular tubercle, so one can calculate *a priori* the depth from the puncture of the needle to the oval orifice. Our examinations proved that the maximal possible failure equals one to two millimetres, which is of no real importance. The arithmetical average of the distance to find equals 6.4 centimetres as determined by the examination of fifty skulls.

In this method of ours as compared with that of Härtel we can in nearly every case beforehand fix the distance from the angle of the lower jaw to the oval orifice, while following the method of Härtel there are no points

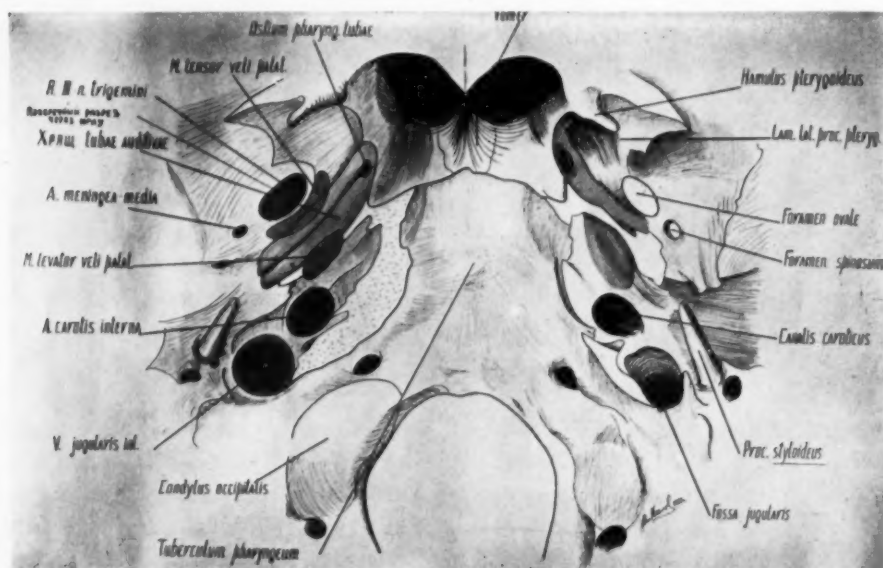


FIG. 1.—Relation of important structures to the skull-base anterior to the foramen magnum.

to rely upon for measuring the distance from the initial point to the oval orifice. After Härtel, the arithmetical average equals five to seven centimetres. The variability of that distance is, of course, considerable, and depends upon the skull form. The oval orifice and articular tubercles being on the same line, the prolonged direction of the needle from the point of puncture on the angle of the lower jaw must coincide with the line uniting the latter with the upper margin of the articular tubercle. We have elaborated this method on cadavers but at the moment of this publication we are not able to verify it on patients.

The technic of penetrating into the Gasserian ganglion after our method is the following: (Figs. 1, 2, and 3)

The patient is lying upon the table for operation, his head hanging downward after the method of Rose—his head is fixed by an assistant.



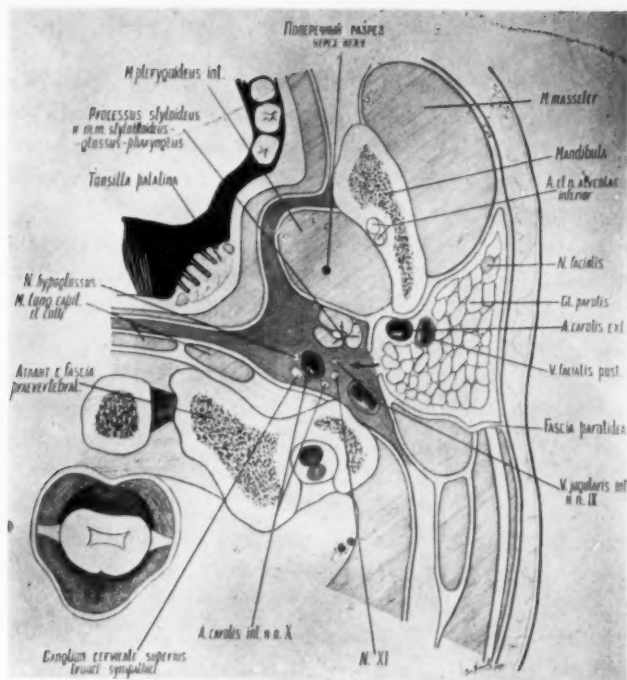


FIG. 2.—Horizontal cut of the skull at the level of the atlas.

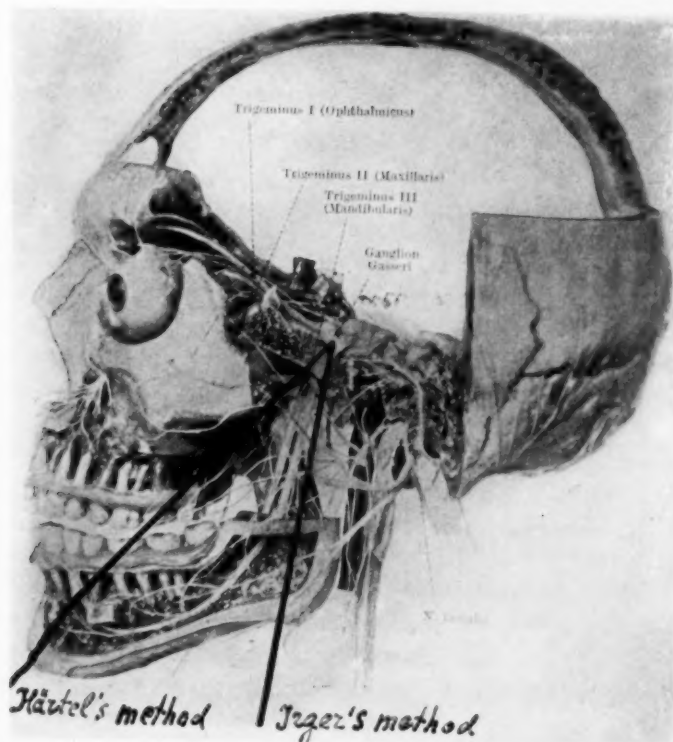
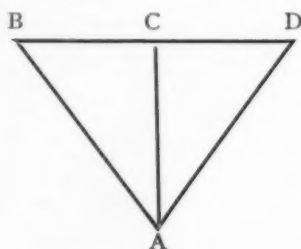


FIG. 3.—Dissection showing the fifth cranial nerve and its branches, demonstrating the course of the needle in penetrating to the Gasserian ganglion by the methods of Härtel and of Irger, respectively.

One previously marks by a little damp bar of silver nitrate the line joining the upper margin of the articular tubercle with the angle of the lower jaw, the mouth of the patient being tightly closed. Covered with iodine, the white silver line becomes very marked. For injections we use needles ten centimetres long and 0.8 millimetre thick. The needle is furnished with a bar, which could be replaced by a cork. We measure from the point of the needle to the bar, a distance equal to that from the angle of the lower jaw (the mouth of the patient being closed) to the upper margin of the articular tubercle and we introduce the needle into the skin of the internal plane of the lower jaw angle. The point of the needle has to touch the bone. The needle will be then slowly advanced till the bar follows the direction of the skull base. To verify whether the needle really advances to the foramen ovale the following data shall be taken into consideration: the needle can be declined in sagittal or frontal direction. To avoid the sagittal deviation one has to remember that the articular tubercles and the oval orifices are upon one line; the prolonged direction of the needle must also coincide with the line uniting the puncture point with the upper margin of the articular tubercle, *i.e.*, with the "silver line."

The frontal deviation (inwards) must be avoided by considering the following figure: (Fig. 4)



A—Angle of lower jaw.

B—Upper margin of the articular tubercle.

D—Oval orifice.

AC—Ascending ramus of the lower jaw.

FIG. 4.

The angle of the lower jaw (A) can, as mentioned, be regarded as the top of an isosceles triangle, the sides of which are formed by lines joining the mentioned angle with the articular tubercle (B) and the oval orifice (D). As AC (the sagittal plane of the ascending branch of the lower jaw), draws perpendicularly to BD, the angle CAD equals BAC, *i.e.*, the angle of deviation of the needle (AD) from the ascending branch of the lower jaw equals to the angle of deviation from the latter of the "silver line." That is to say, the frontal deviation (inwards) is of no significance; it amounts on an average a 22° angle.

When treating the question from the practical point of view, one has to keep in mind that at first the needle-point deviates a little to the median line till it does touch the planum intratemporale; by directing the needle-point a bit inwards one necessarily reaches the oval orifice.

The distance from the oval orifice to the upper border of the pyramid of the temporal bone, relying upon the examination of fifty-eight skulls by Härtel, varies from nineteen to twenty-three millimetres, the minimal dis-

# PENETRATING TO THE GASSERIAN GANGLION

tance being of fourteen millimetres. The distance from the oval orifice to the Gasserian ganglion is equal, on the average following our examination, to one centimetre. It is why the needle, after reaching the oval orifice, has to be advanced upward to a distance of one centimetre.

We suppose that the "gliding" of the needle through the oval orifice into the skull cavity after Härtel's method, mentioned by many authors, can be explained by the impossibility to definitely establish beforehand in any case the distance from the point of puncture to the oval orifice.

Running Nrs.	Distance from the angle of the lower jaw		Running Nrs.	Distance from the angle of the lower jaw	
	to the upper margin of the articular tubercle (Tubercul. Articulare)	to the oval orifice (Foramen Ovale)		to the upper margin of the articular tubercle (Tubercul. Articulare)	to the oval orifice (Foramen Ovale)
1	5.3	5.4	27	6.5	6.4
2	5.4	5.4	28	6.5	6.3
3	5.4	5.4	29	6.5	6.5
4	5.4	5.4	30	6.7	6.6
5	5.6	5.6	31	6.8	6.7
6	5.6	5.6	32	5.9	5.9
7	5.7	5.8	33	6.7	6.6
8	5.8	5.9	34	6.9	6.8
9	5.8	5.8	35	7.0	7.1
10	5.9	5.8	36	7.1	7.1
11	5.9	5.7	37	7.1	6.9
12	5.9	5.9	38	7.1	7.0
13	6.0	6.0	39	7.1	6.9
14	6.0	6.0	40	7.2	7.1
15	6.0	6.0	41	7.1	7.3
16	6.2	6.2	42	7.1	7.1
17	6.2	6.2	43	7.3	7.2
18	6.3	6.3	44	7.3	7.2
19	6.3	6.3	45	7.4	7.4
20	6.3	6.2	46	7.4	7.4
21	6.4	6.4	47	7.5	7.7
22	6.4	6.4	48	7.5	7.3
23	6.4	6.4	49	7.5	7.6
24	6.4	6.3	50	7.9	7.9
25	6.5	6.5	Averages	6.4	6.4
26	6.5	6.3			

From this point of view our method doubtless merits attention, as we can in every single case calculate the distance which is to be found.

By using our method we avoid the wounding of vessels; the external and internal carotid arteries and the jugular vein pass behind and outside. The internal upper jaw artery is bent upon the lower jaw and disposed side-wise from the passage of the needle making its way on the external surface of the external pterygoid muscle. At the perpendicular and horizontal sections the cavernous sinus has the shape of a triangle—the base upward and top downward. From the surgeon's point of view, the most interesting is the external partition, as on it pass (from top to bottom) N. trochlearis, the first branch of the N. trigeminus, N. oculomotorius, N. abducens. The internal carotid artery also perforates the external partition of the cavernous sinus.

Following the method of Härtel and of Harris, the needle can easily get into the cavernous sinus and wound the above mentioned nerves and vessels. Using our method we direct the needle upward and so avoid the sinus, which our examinations of cadavers demonstrated.

From the above considerations it may be concluded that with some practice the penetrating into the Gasserian ganglion, following our method, does not present much difficulty.

#### LITERATURE

- Bange: Central Review of Surg., No. 40, 1926.  
 Bier, Braun, and Kümmel: Oper. Surgery, vol. i, 1922.  
 Bogolubow, W. L.: New Surg. Archives, vol. iv, 1923.  
 Bourguet: Central Organ for the Compl. Surg., vol. xl, No. 7, 1927.  
 Braun: Local Anæsthesia, 1921.  
 Breitländer: Central Review of Surg., No. 50, 1926.  
 Corning: Topographical Anatomy, 1923.  
 Coughlin, William: Central Organ for the Compl. Surg., vol. xlii, No. 4, 1928.  
 Drott: Central Review for Surgery, No. 38, 1928.  
 Eichhorst: Neuralgies.  
 Frazier: Central Organ for the Compl. Surg., vol. xli, No. 9, 1928.  
 Gutnicoff: Archives for Clin. Surg., vol. cxxxv, 1-2 books, 1925.  
 Härtel, Fritz: Local Anæsthesia, 1920.  
 Hitchel: A manual for Local Anæsthesia, 1923.  
 Heymann, E.: German Journal of Surg., vol. ccxvi, n.1-2, 1929.  
 Hoppe: Central Organ for the Compl. Surg., vol. xli, No. 5, 1928.  
 Hoppe: Central Organ for the Compl. Surg., vol. xlii, No. 4, 1928.  
 Hüntemann: Central Organ for the Compl. Surg., vol. xl, No. 7, 1927.  
 Kantorowitz: Central Organ for the Compl. Surg., vol. xlii, No. 4, 1928.  
 Kulenkampf: Central Review of Surg., No. 4, 1926.  
 Kulenkampf: Central Review of Surg., No. 40, 1926.  
 Laajer: Central Organ for the Compl. Surg., vol. xlii, No. 3, 1928.  
 Lexer: Central Review of Surg., No. 41, 1926.  
 Malkin: Russian Journal for Ophthalmology, 1926.  
 Meyer: Central Organ for the Compl. Surg., vol. xli, No. 2, 1928.  
 Nasarow, N. J.: The Application of Alcohol in the Surgery of Nerves. 1915.  
 Orth: Central Review of Surg., No. 41, 1926.  
 Perpina: Central Organ for the Compl. Surg., vol. xli, No. 5, 1928.  
 Pilcher: Central Review of Surg., No. 41, 1926.  
 Polcsow, A. W.: Transactions of the Second Surg. Congress. From the Odessa Department, 1925.  
 Pussen, L. M.: The Principles of Surg. Pathology of Nerves.  
 Rasumowski, W. I.: New Surg. Archives, vol. iii, 1923.  
 Romanzew, N. I.: New Surg. Archives, No. 21, 1924.  
 Serenin: The Transactions of the Sixth Russian Surgical Congress.  
 Sharpe, William: Central Organ for the Compl. Surg., vol. xli, No. 11, 1928.  
 Stokey: Central Organ for the Compl. Surg., vol. xlii, No. 9, 1928.  
 Tichonovich, A. W.: Russian Surgery, 1916.  
 Walter, and Lax: M. m. W., No. 16, 1926.  
 Watkins: Central Organ for the Compl. Surg., vol. xli, No. 14, 1928.  
 Wischnewsky, A.: Central Review of Surg., No. 19, 1926.  
 Yanowski, W. L.: Scientific Medicine, No. 4-5, 1919.  
 Yrger, Y.: Central Review for Surg., No. 27, 1928.  
 Yasnetzky-Wojno, W. F.: Regional Anæsthesia. Diss., 1915.



## CALCIUM CHANGES IN THE BRAIN IN ETHER ANÆSTHESIA

BY EDMUND ANDREWS, M.D., WILLIAM F. PETERSEN, M.D.,  
AND REUBEN I. KLEIN, M.D.

OF CHICAGO, ILL.

FROM THE DEPARTMENTS OF SURGERY AND PATHOLOGY OF THE UNIVERSITY OF ILLINOIS

IN A recent communication it was reported by one of us that following ether anæsthesia profound changes occurred in the mineral salt balance of the blood. Concurrent chemical studies on the same individuals showed that the changes in the acid-alkali equilibrium, blood sugar, chlorides, blood-pressure, pulse, and a number of other factors were not of sufficient importance in the period of convalescence from anæsthesia to account for the patient's condition, but that a most striking feature was an exceedingly marked lowering of the Ca-K ration which in most cases fell below one during some portion of the twenty-four hours of anæsthesia. Marked changes in the permeability of the tissues as shown by the blister method of Gaennslen<sup>2</sup> (using a modification elaborated by Petersen<sup>3</sup>) were also discovered in these cases.

Blood Ca changes in anæsthesia had also been noted by other observers, especially by Emerson.<sup>4</sup> The importance of the Ca-K ration in such conditions is also brought out by Warner<sup>5</sup> whose studies on chorea showed a marked lowering of the ratio. Fischer<sup>6</sup> has made a very elaborate series on the Ca-K ratio in sleep and showed that it was a constant finding that the blood Ca was raised in sleep and the blood K lowered. This was true not only in normal sleep but in sleep brought on by hypnotics. These experiments were done on animals and he noted that these changes were abolished after decerebration. With these points in view, it was decided to study the matter from the standpoint of the Ca in the tissues themselves.

*Protocols.*—Nine dogs were used that were divided into groups of three each and each of them anæsthetized deeply with ether for forty-five minutes. One group was killed at the end of four hours, one at ten hours, and one at sixteen hours. During these periods frequent blood chemistry analyses were made. The carbon dioxide combining power was estimated by the method of Van Slyke and Cullen;<sup>7</sup> the phosphates by the method of Benedict and Theis;<sup>8</sup> the blood sugar by the method of Folin and Wu;<sup>9</sup> and the chlorides by that of Whitehorne.<sup>10</sup> The calcium was determined by the method of Kramer and Tisdall<sup>11</sup> and the potassium by the Kerr's modification of the Kramer-Tisdall<sup>12</sup> method. The pH determinations were made by the Myers and Muntwyler<sup>13</sup> method, except that the plasma separation tubes were not used. The killed animals were then autopsied and the calcium and chlorides determined in the brain and liver. Two other normal dogs were killed and the brain calcium determined as controls. In all cases here reported the tissue calcium determinations were run in duplicate and the figures checked within 10 per cent.

*Methods.*—The method of tissue analysis was as follows: For moisture determination ten grams of tissue are weighed out and dried to constant weight. For analysis

approximately ten grams of tissue were weighed out into a large pyrex glass tube three by sixteen centimetres. A glass tube of diameter of one centimetre and sixty centimetres long was used as a reflux condenser. Twenty cubic centimetres of 20 per cent. NaOH was added and the material boiled on an electric hotplate for about forty-five minutes. Nitric acid was then added until the material was strongly acid and it was reboiled until solution was as complete as possible. The material was filtered through a calcium-free filter. The residue together with the filter paper was

ashed in a nickel crucible with the aid of sodium carbonate and the ash taken up in 5 per cent. nitric acid and added to the previous filtrate. This was then made up to a volume of 100 cubic centimetres.

For calcium analysis ten cubic centimetres were placed into a fifteen-cubic-centimetre tapered centrifuge tube. Two cubic centimetres saturated ammonium oxalate was added and the material made neutral to methyl red with ammonium hydroxide and allowed to stand over night.

The material was then centrifuged and washed with five-centimetre portions of 2 per cent. ammonium hydroxide three times, the supernatant fluid being removed each time by inverting the tube and letting it drain for five minutes. The precipitate was then dissolved in two cubic centimetres of normal sulphuric acid and titrated with N/100 potassium permanganate in a water bath at a temperature of 70° to 80°.

**Results**—It will be seen, as has been pointed out by us previously,<sup>1</sup> that the chlorides are exceedingly variable and fluctuate within normal limits after anaesthesia, this probably being due to the absorption or secretion of electrolytes in the gastrointestinal tract. The blood sugar shows the characteristic marked rise which is well known to occur following ether anaesthesia. The CO<sub>2</sub> and the pH run in general parallel curves in which a mild acidosis is evident but it is certainly not extreme. The blood Ca and K show the same changes, decrease in the K and a rise in the Ca, which has been reported by us before. As was noted in our former paper on the subject, these changes are similar qualitatively to those which occur in man but of a markedly less degree.

The important point, however, is as follows: There is a marked progressive rise in the calcium in the brain. This is of a rather extreme nature rising

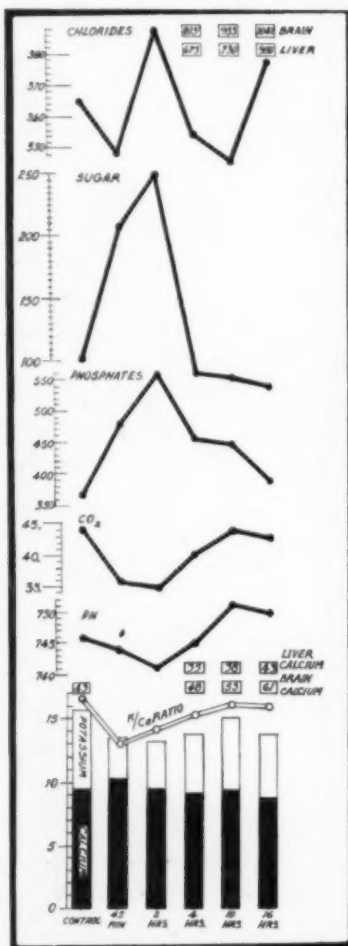


FIG. 1.—Curves represent average blood findings. Numbers in squares are average tissue finding of dogs killed at stated times.

from a level of forty-three to sixty-one milligrams per 100 cubic centimetres dry weight. There is an equally marked passage of Ca into the tissues of the liver and a rise of lesser degree in the chlorides of the liver.

**Discussion.**—It has been a much discussed point whether the well-known phenomena of permeability and irritability of cells based on the changes in the electrolyte content, especially the relation of monobasic to dibasic ions, are due to changes in content of these ions in the media or whether they are

actually part of the cell membrane or cell protoplasm. Leiboff<sup>14</sup> reports the total absence of Ca from the red blood-cells and his work appears to be the most conclusive, since he used large volumes of material and his chemical methods seem reliable. Of course, red blood-cells make ideal material for study in this field because it is possible, at least theoretically, to free them from the surrounding material by washing, a process which is an obvious impossibility in any other tissue.

In these findings Leiboff is in agreement with Abderhalden,<sup>15</sup> Marriott,<sup>16</sup> and also with Rothwell.<sup>17</sup> However, there is some older work in which it has been reported that washed red-cells contain calcium, notably that of Cowie and Calhoun<sup>18</sup> and of Jones and Nye.<sup>19</sup> Other studies of electrolytes in the tissues have also given rather contradictory results.

Ranson<sup>20</sup> was unable to find any difference in the calcium content of normal muscles and muscles during parathyroid tetany confirming the work of Behrendt,<sup>21</sup> although Loughridge<sup>22</sup> found that the calcium was markedly lessened in the muscle tissues. Urano<sup>23</sup> found no calcium at all in the juices which he expressed from muscles of frogs legs. Quagliarello<sup>24</sup> has made a rather elaborate analysis of the electrolytes in both muscles and muscle juices and found electrolytes in all of them, calcium and potassium occurring in about two-thirds of the amount in them as in the solid muscle, but the sodium occurs in apparently equal amounts in the juice and in the muscle.

In this connection it is interesting to note the work on the mineral content of the skin. Elaborate studies by Nathan and Stern<sup>25</sup> of the skin in normal and pathological conditions led them to conclude that there was increased calcium under pathological conditions although there was a wide fluctuation in their normal findings. Previous to this the elaborate studies of Brown<sup>26</sup> on the mineral salts in the skin show rather clearly that an increase in Ca in the skin made it less irritable and that an increase in K made the skin more irritable. Also that the injection of Ca will reduce the irritability of the skin.

It can be seen from this brief review that, while the question is probably still an open one, most of the evidence appears to be that, for the tissues, excluding the human red cells, the well-known changes brought about by fluctuations in the mineral salt balance are due to actual changes in the cellular content of the electrolytes and not simply due to changes in the electrolytes in the surrounding medium.

Our own figures tend strongly to confirm this viewpoint, as can be seen by references to the chart. A change of 50 per cent. in the brain calcium has taken place. When one considers the amount of blood and serum which is included in any tissue Ca estimation, one would feel justified in assuming the changes in the electrolytes in the cells are of even greater degree. It would indicate probably at least 100 per cent. increase because at the very time when the brain Ca was at its highest, the blood Ca had returned to normal. There have been a few other publications on brain

Ca which tend to support this view. Quest<sup>27</sup> reports that the calcium in the brain is very high at birth and sinks rapidly as soon as the brain begins to function and that in children dying of tetany the brain Ca is much lower. Weigert<sup>28</sup> studied the brains of two puppies which died during tetany and found that the Ca was also much lower than in the controls. Cooke<sup>29</sup> reports diminution in the brain calcium of parathyroid-ectomized animals, and Macallum<sup>30</sup> has made detailed studies of Ca in the different parts of the brain during parathyroid tetany and finds that it is lowered about 40 per cent. in the cerebrum and slightly less in the lower brain.

All these figures of course are based on chemical studies such as ours in which the extraction of blood was impossible and therefore the actual changes in the cellular Ca were probably consistently higher than the figures would indicate.

It may also be noted on our chart that the inorganic phosphate of the blood rose markedly and then fell rather rapidly to its original value. This is interesting in view of the work of Boyd<sup>31</sup> showing that a hyperphosphatemia causes an increased excretion of Ca and goes along with the experiments of Jaffee and Bodansky<sup>32</sup> on experimental osteitis fibrosa cystica who were also able to show the depletion of the body of Ca accompanied by a hyperphosphatemia. Our experiments indicate, therefore, that a rise in phosphorus is accompanied by withdrawal of calcium from the blood not only into the excretory organs, as shown by the above authors, but into the tissues as well.

#### CONCLUSIONS

1. Ether anaesthesia in dogs is accompanied by a marked rise in the calcium in the brain as well as in the liver.

2. These changes are probably to be interpreted as meaning a lesser activity and irritability of the brain cells due to changes in the mineral salt content in the cells themselves.

#### REFERENCES

- <sup>1</sup> Andrews, E., and Reuterskiold, K.: Studies in Post-operative Blood Chemistry. *ANNALS OF SURGERY*, (waiting publication).
- <sup>2</sup> Gaennslen, M., and Müller, O.: The Permeability of the Capillary Walls. *Muench. Med. Woch.*, vol. lxi, p. 263, 1922.
- <sup>3</sup> Petersen, W. F.: The Permeability of the Capillaries of the Skin in Various Conditions. *Arch. Int. Med.*, vol. xxxix, p. 19, January, 1927.
- <sup>4</sup> Emerson, W. C.: The Effect of Anaesthesia and Shock on the Calcium Content of the Blood. *J. Lab. and Clin. Med.*, vol. xiv, p. 195, December, 1928.
- <sup>5</sup> Warner, E. C.: The Calcium Metabolism in Acute Stages of Chorea in Children. *Lancet*, vol. i, p. 339, 1930.
- <sup>6</sup> Fischer, H.: Die Rolle des Calciums beim Zustandekommen von Narkose. *Ztschr. f. exp. Path. u. Pharm.*, vol. cxxxviii, p. 169, 1928.
- <sup>7</sup> Van Slyke, D. D., and Cullen G.: Studies in Acidosis. *Jour. Biol. Chem.*, vol. xxx, p. 289, 1917.
- <sup>8</sup> Benedict, S. R., and Theis, R. C.: A Modification of the Molybdic Acid Method for the Determination of Inorganic Phosphorus in the Serum. *Jour. Biol. Chem.*, vol. lxi, p. 63, 1924.

# BRAIN CALCIUM IN ETHER ANÆSTHESIA

- <sup>9</sup> Folin, O., and Wu, Hsein: A System of Blood Analysis. J. Biol. Chem., vol. xli, p. 367, 1920.
- <sup>10</sup> Whitehorne, J. C.: A System of Blood Analysis. J. Biol. Chem., vol. xlv, p. 449, 1921.
- <sup>11</sup> Kramer, B., and Tisdall, F. F.: Studies in the Inorganic Composition of the Blood. J. Biol. Chem., vol. lxxvii, p. 689, 1926.
- <sup>12</sup> Kramer, B., and Tisdall, F. F.: A Simple Technic for the Determination of Calcium and Magnesium in Small Amounts of Serum. J. Biol. Chem., vol. xlvii, p. 475, 1921.
- <sup>13</sup> Myers, V. C., and Muntwyler, E.: Colorimetric Estimation of the Hydrogen Ion Concentration in Blood. J. Biol. Chem., vol. lxxvii, p. 243, 1928.
- <sup>14</sup> Leiboff, S. L.: Calcium Distribution in Blood. J. Biol. Chem., vol. lxxxv, p. 759, 1930.
- <sup>15</sup> Abderhalden E.: Physiological Chemistry, New York, 1911.
- <sup>16</sup> Marriott, W. McK.: Calcium and Magnesium in Blood Serum. J. Biol. Chem., vol. xxxii, p. 233, 1917.
- <sup>17</sup> Rothwell, C. S.: The Determination of Calcium in Whole Oxalated Blood. J. Biol. Chem., vol. lxxiv, p. 257, 1927.
- <sup>18</sup> Cowie, D. M., and Calhoun, H. A.: Presence of Calcium in Red Blood-corpuscles in Man and Ox. J. Biol. Chem., vol. xxxvii, p. 505, 1919.
- <sup>19</sup> Jones, M. R., and Nye, L. L.: Distribution of Calcium and Phosphorus in Blood of Normal Children. J. Biol. Chem., vol. xlvii, p. 321, 1921.
- <sup>20</sup> Dixon, H. H., Davenport, H. A., and Ranson, S. W.: Calcium Content of the Muscle during Parathyroid Tetany. J. Biol. Chem., vol. lxxxiii, p. 737, 1929.
- <sup>21</sup> Behrendt, H.: Shifting of Electrolytes between Tissues and Blood. Klin. Woch., vol. iv, p. 1600, 1925.
- <sup>22</sup> Loughridge, J. S.: Phosphate and Calcium Mechanisms in Skeletal Muscle after Parathyroidectomy. Brit. J. Exp. Path., vol. vii, p. 302, 1926.
- <sup>23</sup> Urano, F. Z.: Die Eregerbarkeit von Muskeln und Nerven unter den Einfluss verschiedenen Wassergehältes. Ztschr. f. Biol., vol. i, p. 212, 1908.
- <sup>24</sup> Quagliarello: Contenuto in Na, K, Ca, and Mg del succo musculare e del suo ultrafiltrato. Amer. J. Phys., vol. xc, p. 481, 1929.
- <sup>25</sup> Nathan, E., and Stern, F.: Ueber den Mineralgehalt der Haut unter normalen und pathologischen Verhältnissen. Derm. Ztschr., vol. liv, p. 54, 1928; and vol. liv, p. 232, 1928.
- <sup>26</sup> Brown, H., and Klauder, J. V.: Experimental Studies in Eczema. II Arch. of Derm., vol. xv, p. 1, 1927.
- <sup>27</sup> Quest, R.: Ueber dem Kalkgehalt des Säuglingsgehirn und seine Bedeutung. Jahrb. f. Kinderh., vol. lxi, p. 114, 1905.
- <sup>28</sup> Weigert, R.: Der Kalkgehalt des Gehirns und seine Bedeutung. Monatschr. f. Kinderh., vol. v, p. 457, 1906.
- <sup>29</sup> Cooke, J. V.: Excretion of Calcium and Magnesium after Parathyroidectomy. J. Exp. Med., vol. xi, p. 45, 1910.
- <sup>30</sup> Macallum, W. G., and Voegtlin, C.: Relation of Tetany to Parathyroid Glands. J. Exp. Med., vol. xii, p. 188, 1909.
- <sup>31</sup> Boyd, J. D., et al: The Effect of Experimental Hyperphosphatæmia on Calcium and Phosphorus Excretion. Proc. Soc. Exp. Biol. and Med., vol. xxvii, p. 776, 1930.
- <sup>32</sup> Jaffee, H. L., and Bodansky, A.: Experimental Chronic Hyperphosphatæmia in Dogs without Hypercalcaemia. Proc. Soc. Exp. Biol. and Med., vol. xxvii, p. 796, 1930.



## VALUE OF CORDOTOMY FOR THE RELIEF OF PAIN\*

BY FRANCIS C. GRANT, M.D.

OF PHILADELPHIA, PA.

FROM THE DEPARTMENT OF NEUROSURGERY, HOSPITAL OF THE UNIVERSITY OF PENNSYLVANIA

CORDOTOMY for relief of pain has been practised in this clinic since 1916. During the past fourteen years, fifty-one cordotomies have been performed upon forty-eight patients. Sufficient material, therefore, is at hand from this and other clinics to reach definite conclusions as to the value of this operation in the relief of pain.

The type of case in which section of the pain-conducting pathways in the cord seems indicated can be well illustrated by outlining an early experience with this procedure.

L. W. G., male, aged forty-four, entered the University Hospital in January, 1917. The chief complaint was pain in the rectum, buttocks and thighs. Eighteen months previously rectal examination had revealed a large cancerous growth just above the anal canal filling the lumen of the bowel. Since the growth appeared inoperable, a colostomy had been made and intensive radium therapy instituted. The colostomy functioned well. Pain in the regions described developed and was intense, continuous and demoralizing. Large doses of morphine gave only partial relief. Inasmuch as the tumor was slow-growing with severe pain as its chief symptom, cordotomy seemed indicated. Laminectomy of ninth and tenth thoracic vertebrae was performed and bilateral section of the antero-lateral tracts made at the level of the twelfth thoracic and first lumbar segments.

January 25, 1917, one week after operation, there was a flaccid paralysis of the left lower extremity and both the patella tendon and Achilles tendon reflexes were diminished. There was no motor disturbance of the right lower extremity and the reflexes were normal. Patient complained of bearing-down pain in bladder.

*Physical Examination* (February 2, 1917).—*Right Lower Extremity.* *Sensation.*—Preservation of tactile sensation throughout. Loss of thermal and pain sensation over the buttock, perineum, posterior aspect of the thigh and below the level of the knee. No disturbance of sense of position. *Motion.*—Movements of the limb are unimpaired. *Reflexes.*—Patella and Achilles tendon and cremasteric reflexes normal. Abortive ankle clonus. Dorsal flexion of great toe.

*Left Lower Extremity.* *Sensation.*—Patient can distinguish between hot and cold and the prick of a pin throughout extremity. The sense of touch is preserved although patient states sensation is not so acute in the anterior and lateral surfaces of the thigh. There is no disturbance in the sense of position. *Motion.*—All movements of the left lower extremity, temporarily arrested after the operation, have been restored. *Reflexes.*—Achilles and patella tendon reflexes more active than at last examination, January 25th. Ankle clonus and Babinski present. The patient still has attacks of vesical tenesmus but they are not so frequent nor so painful as formerly.

The patient was discharged April 21, 1917. There had been no change in the sensory disturbances as noted February 2, 1917. Several attempts were made to have the patient return for continued radium treatments, but without success. During the war he was lost sight of.

September 10, 1919, the patient wrote: "I do not feel any soreness in the perineum

\* Read before the Philadelphia Academy of Surgery October 6, 1930.

## CORDOTOMY

or rectum. I ride a bicycle a great deal without discomfort. My appetite and digestion are good and my limbs are strong."

On May 23, 1920, just four years after the patient came under observation, his condition was reported through a verbal communication as very satisfactory.

In June, 1922, the patient was reported to have died from unknown cause, three months ago. There had been no recurrence of pain.

[This is Case III previously reported by Frazier in Arch. Neurol. Psych., 1920, vol. iv., p. 137.]

*Comment.*—This is an excellent example of the value of cordotomy. It was not the malignant tumor of itself but the pain it produced by pressure on sensory nerves that would have shortly destroyed the patient. Once this pain was relieved by cordotomy he lived comfortably for five years.

If in the course of a disease sensory nerves are affected, pain at once becomes a most distressing feature. And there is no more intense, continuous, or intractable pain than that arising from involvement of the posterior roots of the spinal cord by neoplasms or inflammation within or without the vertebral canal. Furthermore, if in addition to the pain the sufferer is aware that its cause may be a malignant, incurable disease, the mental as well as the physical anguish to be endured is easily appreciated. In the past, for the most part, recourse to morphine has been necessary to render life bearable, at best an unsatisfactory intermittent relief, requiring increasingly large amounts of the drug to dull the pain. However, the value of sectioning sensory pathways leading from the site of the pain has long been appreciated though but infrequently employed. Dana in 1886 first proposed section of the posterior roots of the spinal cord to afford relief, and Bennett<sup>1</sup> and Abbé<sup>2</sup> reported the first successful results from this procedure. Although Chipault,<sup>3</sup> Ballance,<sup>4</sup> Groves,<sup>5</sup> Hildebrand,<sup>6</sup> Jacoby,<sup>7</sup> Jones,<sup>8</sup> Foerster,<sup>9</sup> and others gave posterior rhizotomy a thorough trial, the operation gradually fell into disrepute. It was abandoned because there is such a marked overlapping of sensory nerve distribution to the same skin area that to produce complete anaesthesia at least three roots must be cut. Hence, two roots above and below the region involved had to be sectioned. Consequently, if the pain was widespread a very extensive laminectomy and rhizotomy was necessary, an operative procedure of such magnitude that it involved great risk to an already debilitated patient. Furthermore, when the posterior roots have been severed sensory loss in the parts involved is complete, motion and position discrimination as well as pain and temperature being abolished, which interferes markedly with proper motor control. It was obvious that until the pain fibres alone could be picked out, relief of pain by section of sensory pathways was accompanied by too many handicaps to be considered entirely practical.

Although in 1879, Gowers<sup>10</sup> suggested that pain and temperature fibres probably passed upward within the cord in the tract that bears his name, a fact which Van Gehuchten<sup>11</sup> asserted positively in 1893, it was not until 1904 that the brilliant clinical observations of Spiller<sup>12</sup> proved that these sensations were carried upward in the antero-lateral tract. In 1910 Schuller<sup>13</sup> on purely

theoretical grounds advised that sensory pathways in the cord might be cut to relieve the pain arising from gastric crises. Petren,<sup>14</sup> Rothman,<sup>15</sup> and Fabritius<sup>16</sup> on clinical and experimental grounds confirmed Spiller's findings. But in 1912 Spiller and Martin<sup>17</sup> reported a case operated upon January 19, 1911, in which bilateral cordotomy or section of the antero-lateral pathways in the cord was performed for relief of pain due to a malignant inoperable tumor on the left side and lower part of the spinal cord. As Spiller anticipated, the pain was relieved, although touch and position sense seemed unimpaired. Upon examining the patient a year later, he felt that the operation had been successful. It is to Spiller, therefore, that the credit for originating this valuable and merciful suggestion must be given. At this same time Cadwalader and Sweet<sup>18</sup> at Spiller's suggestion performed experimental work on dogs which gave further evidence that pain fibres were carried through these antero-lateral pathways. Although Beer,<sup>19</sup> Souttar<sup>20</sup> and Tietze<sup>21</sup> at Foerster's suggestion performed cordotomy for relief of pain with success, pain being relieved without impairment of motion or sense of touch or position, the operation did not receive the attention it merited until the report of Frazier<sup>22</sup> appeared. Spurred on by Spiller, six cases, having intractable pain in the lower extremities, due to malignant tumors or gunshot wounds involving the lower spinal cord or the posterior roots, had cordotomies performed with complete or marked relief of pain. Three years later in further collaboration with Spiller<sup>23</sup> seven additional cordotomies were described by Frazier. In these cases pain sensation was destroyed without motor impairment or complete loss of other sensations which had proved to be the great disadvantage of posterior rhizotomy. Based on his experience Frazier perfected a method which made easy a section of only the antero-lateral tracts, and avoided damage to the motor fibres. As a result of Frazier's description of the technic of cordotomy and a confirmatory report of Leighton,<sup>24</sup> who relieved three cases of gastric crises and one of severe pain in the legs following spinal trauma by this procedure, the value of section of the antero-lateral columns for relief of pain was firmly established.

Since the appearance of Frazier's and Spiller's report, Sicard and Robineau,<sup>25</sup> Peet,<sup>26</sup> Banzet,<sup>27</sup> Foerster,<sup>28</sup> Horrax,<sup>29</sup> Stookey,<sup>30</sup> Stebbing,<sup>31</sup> Beck,<sup>32</sup> Towne<sup>33</sup> and Bankart<sup>34</sup> have all recorded series of cases successfully relieved of pain by this procedure. Sufficient time has elapsed, therefore, and enough clinical material is available in the literature and from the 48 cases from this clinic to arrive at a just conception of the value of this procedure.

Cordotomy has three distinct advantages over the other methods of relieving pain. Firstly, a greater area of anaesthesia can be produced by section of the antero-lateral pathways than by any other means; secondly, pain and temperature sensations alone are obliterated without involvement of touch or position sense and hence motor function remains unimpaired; lastly, the operative procedure requires only a small laminectomy and is, therefore, much less exhausting to debilitated patients. But cordotomy has the disadvantage that unless the incision into the cord is accurately placed, the pain may not be

## CORDOTOMY

completely relieved or the motor pathways may be damaged, resulting in paralysis of the legs and interference with sphincteric control.

A very distinct advance in the technic of cordotomy has recently been made following the discovery that section of the pain fibres in the cord causes the patient no distress. Manipulation of the posterior roots is painful, but curiously enough cutting into the antero-lateral tracts is not. Hence the operation may be carried out under local anaesthesia, or preferably nitrous oxide analgesia plus local anaesthesia, which holds the patient quiet until the adjacent posterior roots have been separated and the cord rotated ready for cordotomy. The anaesthesia is then stopped so that tests of level of sensory loss following incision into the cord may be made on the conscious patient. The reports of Foerster<sup>9</sup> and Wilson and Fay<sup>20</sup> have shown that the section in the cord may be gradually deepened until just sufficient pain fibres are cut to produce anaesthesia to the level required and no higher. Since the fibres that supply the lower extremities lie most superficial in the antero-lateral columns, by this means carrying the incision to an unnecessary depth into the cord and hence possible injury to the pyramidal tracts may be avoided. Furthermore, Spiller suggested to Wilson and Fay that by immediate testing in this way it might be possible so to place the incision that the pain fibres alone were cut and temperature tracts avoided. Stookey reported four cases in which following a relatively shallow cordotomy temperature sense was retained although anaesthesia to pain was produced. Recent cases from this clinic have confirmed these findings. Such observations are extremely important from the neurophysiologic standpoint as they offer definite proof that pain and temperature fibres run in separate and distinct fibre tracts in the cord. The reports quoted and our own experience seem to suggest that the temperature fibres are located more centrally, while the pain fibres lie superficially over a larger surface area. If the incision is carried from exactly the plane of attachment of the dentate ligament forward to just beyond the level of the emergence of the anterior root, it need not penetrate to a greater depth than  $2\frac{1}{2}$  millimetres at any point. If the pain is referred to an area lying below the iliac crest, immediate tests may show a level of anaesthesia above this region before a depth of 2 millimetres has been reached. When the importance of avoiding too deep a section which may involve the pyramidal tracts and result in paralysis is considered, this suggestion of Spiller's is a distinct advance in the technic of cordotomy.

Cordotomy may be performed either unilaterally or bilaterally depending on the extent of the pain. If the pain is referred to the bladder or rectum, or if it is caused by a rapidly spreading malignant tumor, the wiser course is to do a bilateral section. When both antero-lateral columns are to be cut, the incisions should not be made at the same level, but must be separated by at least one whole segment. In this way interference with the blood supply to the cord, possibly producing a transverse lesion, is avoided. The cord may be sectioned as high as the sixth cervical segment if necessary. Incision at a higher level may involve the phrenic distribution, causing respiratory embar-

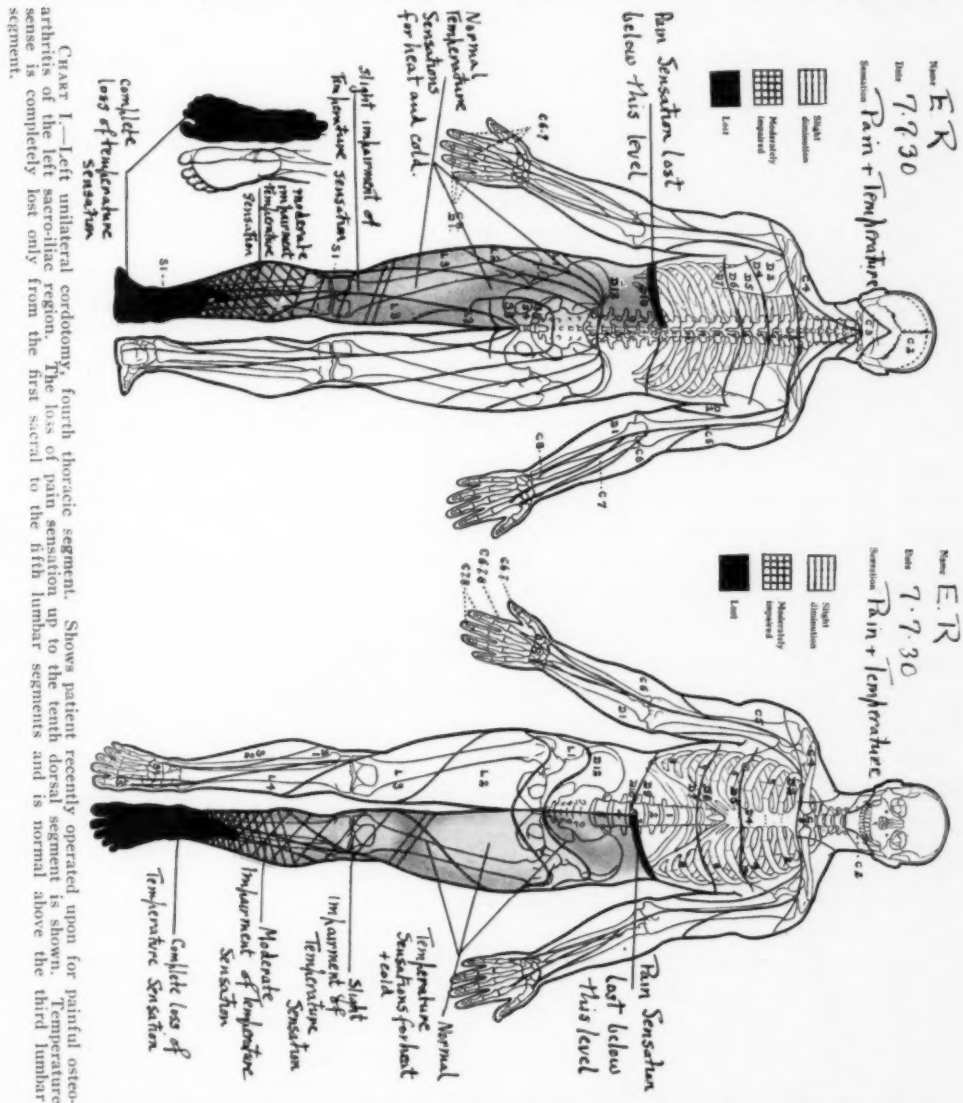
rassment. The third or fourth thoracic segment is the point of election for cordotomy. In this region the vertebral curve brings the cord into a relatively superficial position, the cord is small and may be rotated easily, all possibility of diaphragmatic involvement is avoided, and anaesthesia as high as the ensiform cartilage may be produced. The operative incision is made in the mid-line from the first to the fifth thoracic spines and the second, third and fourth spines and laminae removed. It is important that the laminae be rongeured away as widely as possible, for the greater the lateral exposure the more readily may the cord be rotated for section. After haemostasis has been completed, the dura is carefully opened and retracted to either side with stay sutures. If possible the arachnoid should be included in the sutures and reflected with the dura. Care must be taken, however, in reflecting the arachnoid lest a fine blood-vessel or two which pass from it to the cord may be torn. Even the slightest haemorrhage impairs the chances of a successful result. Next a dentate ligament as near the centre of the incision as possible is identified and the anterior and posterior roots running adjacent to it separated from the cord. Extreme delicacy should be used in handling the roots, first because minute arteries accompany them, and second, because manipulation of the posterior root is painful and may cause the patient to strain. The dentate is seized in a mosquito haemostat and cut at its dural attachment. Gentle traction on this ligament will rotate the cord posteriorly until the point of emergence of the adjacent anterior root and the anterior fissure of the cord may be seen. The incision into the cord is the next step. Posteriorly the section should begin exactly at the point of emergence of the dentate ligament, extend anteriorly to just beyond the level of emergence of the anterior root and reach a depth of  $2\frac{1}{2}$  millimetres at its mid-point. It is difficult to place the incision exactly for the pia over the cord seems at times very tough and resistant, and the dentate ligament may be torn off during the attempt to cut the lateral columns, leaving no way of steadying the cord. For this reason the cordotomy hooks devised by Frazier are important. By their use the cord may be steadied so that a much more accurate section is possible. It has been stated by a number of observers (Horrax and Peet) that the cordotomy hooks fail to permit of a sufficiently deep section to produce complete relief of pain. Therefore, they advise the use of a straight cataract knife for making the incision. The first cordotomies in this clinic were performed in this way. The very obvious difficulty of controlling the cord with the dentate ligament alone forced the development of the hooks. Since this method of steadying the cord was adopted, in but three cases in thirty-nine in which the hooks were used, not only to steady the cord but to limit the depth of the section, has the incision failed to cut sufficient fibres to relieve the pain. In four cases in this clinic done under local or nitrous oxide anaesthesia, so that the level of sensory loss could be determined as the section was made, the cordotomy hook was introduced in a very superficial manner just under the pia at a point immediately anterior to the insertion of the dentate ligament. The hook steadied the cord perfectly as with a straight



# CORDOTOMY

knife the usual section was made and deepened until the sensory tests coincidentally carried out showed that the level of anæsthesia had reached the required height. The results in these cases were extremely satisfactory.

If the loss of sensation is to be determined during the operation it is important that the patient be fully acquainted in advance with the type of tests to be employed. Accurate responses will not be obtained from a patient



operated upon under gas-oxygen anæsthesia and allowed to regain consciousness during the actual incision into the cord, for the mental confusion will be too great unless the methods of determining the level of anæsthesia have been carefully rehearsed beforehand. While we have tried local anæsthesia alone in these cases, it is our opinion that it is too painful a procedure, especially when the posterior roots are handled, to be recommended.

The results of the fifty-one cordotomies on forty-eight patients in this series are given in detail in Tables I, II, III and IV. The anaesthesia produced by proper section of the antero-lateral columns at the level of the third or fourth thoracic segments has been so repeatedly illustrated by reports from this and other clinics that further comment here is unnecessary.

The real test of the value of cordotomy is the degree of relief from pain it affords. In experienced hands there is no doubt but that immediate complete relief of pain may be confidently assured. Complete relief of pain is rigidly defined in this series. The patient must be actually pain-free without

TABLE I  
*Cordotomy*

48 cases	51 cordotomies
31 males	17 females
Average age 47 years	
Bilateral cordotomy .....	29
Unilateral cordotomy .....	22
Completely relieved .....	39
75 per cent. relieved .....	8
50 per cent. relieved .....	2
Not relieved .....	2

recourse to morphine or other type of sedative to be so classified. In the four cases described as only 50 per cent. relieved or not relieved at all, unilateral cordotomies were performed when both columns should have been sectioned and pain appeared promptly on the opposite side. Very careful questioning as to the site and distribution of the pain is essential. Often these patients have a major pain in one region of which they complain with great bitterness, failing to mention a moderate amount of distress referred to the opposite side. When the antero-lateral columns contralateral to the side of the major pain are sectioned with consequent relief, the hitherto minor distress on the opposite

TABLE II  
*Cordotomy*  
Cause of pain

Malignancy of G-U tract or genitalia .....	18
Malignancy vertebræ .....	8
Gunshot wound spine .....	4
Sarcoma hip .....	4
Retroperitoneal sarcoma .....	2
Painful stump .....	2
Tabetic crises .....	2
Other causes .....	8

side remains and is magnified until the situation is well-nigh as bad as it was before operation. Occasionally the pain lies high up about the umbilicus or even as high as the ensiform. This is frequently the distribution in gastric crises. Under such circumstances cordotomy at the fourth thoracic segment will have to be very carefully placed and all the fibres sectioned to bring the level of anaesthesia above this region. Although sensory examinations following cordotomy seem to show (Foerster) that pain fibres decussate in the cord within one segment of the level of their point of entrance, and hence cordotomy at the fourth thoracic segment should produce skin anaesthesia as high as the fifth dermatome, if it is necessary to produce loss of pain right

## CORDOTOMY

up to the level of the cord section it is wise to tie and cut the posterior roots that lie in the operative field. The second, third, fourth, fifth and at times the sixth thoracic roots may be seen in the usual cordotomy incision. If the pain to be relieved is situated above the umbilicus, cordotomy should be supplemented by rhizotomy of the ipsilateral posterior roots thus exposed. Patients with gastric crises should have rhizotomy as well as cordotomy, for in tabetic cords the adhesions make accurate section of the pain fibres difficult, and, furthermore, the pain is often referred well up under the sternum.

Where a chronic stationary condition such as osteo-arthritis, a painful

TABLE III  
*Bilateral Cordotomy*  
Twenty-nine Cases  
Complications

Vomiting .....	3
Distension .....	4
Retention urine .....	8
Motor weakness .....	6
Died .....	3
Meningitis .....	1
Shock .....	1
Cachexia .....	1

stump, a gunshot wound or other injury to the pelvis involving the lumbosacral nerves, or tabetic crises, is the cause of severe incapacitating pain, the indication for its relief by cordotomy is unquestioned. Such patients may have a normal life expectancy and cannot continue indefinitely to dull the pain with morphine. Fourteen such cases are included in this series. One died following cordotomy. Five of the remainder are known to be alive and pain-free. Six could not be traced and three are dead after an average life period of five years, during which they had no further complaints.

TABLE IV  
*Unilateral Cordotomy*  
Twenty-two Cases  
Complications

Vomiting .....	1
Distension .....	1
Retention .....	2
Motor weakness .....	1
Died .....	4
Cachexia .....	2
Pneumonia .....	2

But where a malignant tumor, especially a rapidly spreading growth, produces pain, then the point can be raised that the sufferer may be made comfortable by morphine for the last few months of life without subjecting him to the added distress of an operation. Frankly, we think that such an argument smacks of sheer cruelty. Cordotomy in experienced hands is so certain to give relief, the period of acute post-operative discomfort is never over five days, that we feel it is an entirely justifiable procedure provided that the patient is not a hopeless operative risk. However, cord section is never insisted upon, the sufferer only being told that he can be made entirely comfortable if he is willing to have the procedure carried out. Most of these

unfortunates gladly accept any chance of relief for they know how intermittent and unsatisfactory are the results of sedative drugs. Of the twenty-six patients having pain caused by malignant disease, one lived five years (Case I), and the post-operative life period of the other twenty-five averaged just over nine months following cordotomy.

It seems obvious that this suggestion of Spiller's for relieving intractable pain by section of the antero-lateral columns of the spinal cord is a practical, justifiable and merciful procedure. When its possibilities are more widely appreciated and when patients are brought to the surgeon before they are so debilitated by cancer or weakened by constant suffering that they are bad surgical risks, the mortality will be reduced. It behooves the medical profession at large to realize that pain can be relieved easily by cordotomy with relatively little risk, to recommend it earlier, and thus to prevent pain from becoming the harassing factor it has all too often been allowed to develop into in the past.

## REFERENCES

- <sup>1</sup> Bennett: *Med. Chir. Trans.*, vol. lxxii, p. 329, 1889; and *The Lancet*, p. 839, 1889.
- <sup>2</sup> Abbé: *Boston Med. and Surg. Jour.*, vol. cxxxv, p. 329, 1896.
- <sup>3</sup> Chipault: *Gaz. des hôp.*, vol. lxxviii, p. 937, 1897.
- <sup>4</sup> Ballance: *Lancet*, vol. ii, p. 94, 1911.
- <sup>5</sup> Groves: *Lancet*, vol. ii, p. 79, 1911.
- <sup>6</sup> Hildebrand: *Arch. f. klin. Chir.*, vol. xciv, p. 203, 1911.
- <sup>7</sup> Jacoby: *N. Y. Med. Jour.*, vol. lxxxvi, No. 2, p. 192, 1907.
- <sup>8</sup> Jones: *Jour. Am. Med. Asso.*, vol. lvii, p. 1175, 1911.
- <sup>9</sup> Foerster: *Surg., Gyn. and Obstet.*, vol. xvi, p. 463, 1913.
- <sup>10</sup> Gowers: *The Diagnosis of Diseases of the Cord*, 1879.
- <sup>11</sup> Van Gehuchten: *Anatomie du Système Nerveux*, Louvain, 1900.
- <sup>12</sup> Spiller: *Univ. Penna. Med. Bull.*, No. 18, p. 147, 1905.
- <sup>13</sup> Schuller: *Wein Med. Wochenschrift*, vol. lx, p. 2292, 1910.
- <sup>14</sup> Petren: *Arch. f. Psychiat.*, vol. xlvii, p. 495, 1910.
- <sup>15</sup> Rothman: *Monatschr. f. Psychiat. u. Neurol.*, p. 81, January, 1912.
- <sup>16</sup> Fabritius: *Monatschr. f. Psychiat. u. Neurol.*, January, 1912.
- <sup>17</sup> Spiller and Martin: *Jour. Am. Med. Asso.*, vol. lviii, p. 1489, 1912.
- <sup>18</sup> *Jour. American Med. Asso.*, 1912: 58: p. 1490.
- <sup>19</sup> *Jour. American Med. Asso.*, 1913: 60: p. 267.
- <sup>20</sup> Quoted by Armour D., *Lancet*, 1927: 1: 962.
- <sup>21</sup> Frazier, C. H. *Surgery of Spine and Spinal Cord*, D. Appleton, 1918: p. 910.
- <sup>22</sup> *Arch. Neurol. & Psych.*, 1920: 4: 137.
- <sup>23</sup> Spiller: *Arch. Neurol. & Psych.*, vol. ix, p. 1, 1923.
- <sup>24</sup> Leighton: *Surg., Gyn. & Obstet.*, vol. xxxiii, p. 246, 1921.
- <sup>25</sup> *Rev. Neurol.*, 1925: 1: 21.
- <sup>26</sup> *Arch. Surg.*, 1926: 13: 153.
- <sup>27</sup> *La Cordotomie*, Paris, 1927, Librairie Louis Arnette.
- <sup>28</sup> *Arch. f. Psychiat.*, 1927: 81: 7.
- <sup>29</sup> *Arch. Surg.*, 1929: 18: 1140.
- <sup>30</sup> *Jour. Nerv. & Mental Diseases*, 1929: 69: 552.
- <sup>31</sup> *Lancet*, 1929: i: 654.
- <sup>32</sup> *ANNALS OF SURGERY*, 1930: 92: 335 and *Ohio State Med. Jour.*, 1929: 25: 455.
- <sup>33</sup> *Calif. & Western Med.*, 1929: 31: 98.
- <sup>34</sup> *Lancet*, 1929: ii: 378.
- <sup>35</sup> Wilson and Fay: *Arch. Neurol. and Psych.*, vol. xxii, p. 638, 1929.

## POST-OPERATIVE PAROTIDITIS: TREATMENT WITHOUT AND WITH RADIUM \*

BY FRED W. RANKIN, M.D.

AND

BEAN M. PALMER, M.D.

OF ROCHESTER, MINNESOTA

FROM THE DIVISION OF SURGERY OF THE MAYO CLINIC

AMONG the most unexpected and dangerous complications which occasionally follow surgical procedures—especially those that involve the gastrointestinal tract—is an acute, inflammatory, and frequently suppurative process of the parotid gland, unilateral or bilateral. The reason for infection of the parotid gland following operation is not clear, as a glance at the literature, which offers such a multitude of etiologic explanations, shows. High mortality has accompanied this group of cases, particularly when the process has gone on to suppuration, requiring incision. Regardless of treatment, the prognosis is guarded and frequently grave.

Since we have observed the beneficial qualities of radium packs in the early stages of this sequela, it occurred to us to review all of the cases which have occurred at The Mayo Clinic in the last four years, with comparison of the various therapeutic agents employed. The seventy-eight cases which we were able to find, in twenty of which radium was used, showed some very interesting as well as informative facts.

INCIDENCE.—The incidence of this complication after general surgical procedure, including surgical procedures of the upper part of the gastro-intestinal tract and small bowel, is relatively low. Pique, in 1907, in a series of 7200 general surgical operations, encountered two cases of post-operative parotiditis. Likewise, Beckman, in 1903, reporting on complications observed in a series of 6825 surgical operations performed at The Mayo Clinic, encountered only three cases of post-operative parotiditis. The ratio of incidence of this complication was 1 to 3600 in Pique's series, and 1 to 2275 in Beckman's series.

One is immediately impressed, however, with the greatly increased incidence of post-operative parotiditis with the development of surgery of the colon. There must be, it seems, some local cause, incidental to surgical attack on the colon, to some technical procedure in extirpation of the colon, or to the post-operative treatment, which greatly increases the occurrence of parotiditis. Twenty of our seventy-eight cases followed major surgical operations on the colon or the rectum. In the course of the period in which 2,700 operations were performed on the colon and rectum, these twenty cases of post-operative parotiditis occurred. This gives an incidence of one case in

---

\* Submitted for publication May 29, 1930.



135 operations on the colon or rectum, nearly seventeen times as many as the number encountered in general surgery at The Mayo Clinic.

ETIOLOGY.—A review of the discussions of various authors on the etiology of post-operative parotiditis suggests five different theories: (1) according to the pyemic theory, secondary parotiditis is a pyemic phenomenon due to embolism of the parotid vessels, with a septic clot derived from the primary focus of infection; (2) by the heat degeneration theory, secondary parotiditis is recognized as a parenchymatous degeneration of the gland due to hyperpyrexia; (3) in the toxin excretion theory, secondary parotiditis is attributed to infection of the gland following an unsuccessful attempt to excrete toxin manufactured by the organisms of the primary disease; (4) in accordance with the sympathetic theory, parotiditis is produced sympathetically, secondary to operations on the generative organs; and (5) according to the duct infection theory, secondary parotiditis is produced by direct extension of microorganisms along Stenson's duct from the mouth.

Two of these theories, the duct infection theory and the pyemic theory, have gained considerable support in the literature. Among these advocating the duct infection theory may be mentioned Claisse and Dupré (1894), Girode (1894), Hanau and Pilliet (1889), Rolleston and Oliver (1909), Fenwick (1909), and Blair and Padgett (1923). Among those supporting the pyemic theory are Padgett (1886), Bowe (1905), Dyball (1904), and Fisher (1919).

Claisse and Dupré (1894), experimenting with dogs, tried in various ways to produce secondary parotiditis. They found that in normal animals they could not produce the condition by smearing the orifice of Stenson's duct with microorganisms, by injecting virulent organisms into the duct, or by creating an artificial fistula. However, in an animal, the general vitality of which had been depressed, either by starvation or by injection of drugs such as opium which would limit the flow of saliva, infection of the parotid gland could be produced by any of these means.

Bucknell (1905) was one of the first to recognize the importance of the experimental work of Claisse and Dupré. Bucknell wrote: "It is evident, therefore, that for allowing infection to occur in the case of the parotid duct, as has been more or less proved in the cases of the kidney and bile passages, one or the other following abnormal conditions must be present: (1) microorganisms must be present at the orifice of the parotid duct, in larger numbers or of a more virulent type than usual; (2) the general vitality of the subject must be reduced so as to render him more liable to succumb to microbic infection; (3) the quantity of secretion passing down the duct and protecting it must be diminished; and (4) the quantity, and, more particularly, the bactericidal proportion of the saliva secreted must be lowered."

Turning to the question of secondary parotiditis in man, and referring to the disorders which have been complicated by this disease, it is evident that they all present one common feature; that is, they are all likely to be accompanied by those conditions which Claisse and Dupré have shown to be successively present, before infection of the duct can be produced in animals.

In a review of our seventy-eight cases, facts were not discovered which would substantiate a single type of cause in all. In the group of cases in

## POST-OPERATIVE PAROTIDITIS AND RADIUM

which operation was done on the colon, particularly, we were confronted with many conditions which certainly are disadvantageous to any surgical procedure any which may influence complications. Such conditions are age, debility, dehydration, arteriosclerosis, and infection of long standing. Interference with mobility of the colon, and production of obstruction, with its concomitant sequence of steady absorption and devitalization, unquestionably must influence production of the complication of parotiditis. Likewise, it is not at all certain that starvation after operation, which is imposed on patients who have undergone resection of the colon and rectum, may not have an important bearing. Usually, patients subjected to major abdominal procedures are refused fluid by mouth for only twenty-four to forty-eight hours, unless there is some exceptionally valid reason for such deprivation. It has been our routine procedure to keep patients who have had resection of the colon and rectum without food or drink by mouth for three to four days. The content of water of the body is maintained by intravenous injection and hypodermoclysis. At the same time, conservation of function of the parotid gland is attempted by permitting the patient to suck lemons or chew gum. Nevertheless, in spite of all of these precautions, parotiditis occurred nearly seventeen times more often among patients who underwent resection of the colon and rectum than, for example, among patients who underwent gastric operations.

### VARIOUS FORMS OF TREATMENT

All authors are in agreement that as soon as suppuration can be definitely recognized, the gland should be incised, but there is disagreement as to just when suppuration is present. The only sign which is pathognomonic of suppuration in the parotid gland is fluctuation; when this appears the gland should be lanced. It is unwise to lance a gland in the hope of penetrating to a region of deep suppuration because one may be disappointed in finding it, and injury to the facial nerve is almost certain to result. We have frequently seen glands rupture and discharge from the ear before suppuration could be demonstrated by the sign of fluctuation, and then, after the gland has been lanced, we have seen a satisfactory outcome. Unnecessary drainage of the gland, and, perhaps, spread of the infection, is frequently avoided by waiting for a definite sign. In many cases, under the influence of hot fomentations or ice, as the choice of the surgeon indicates, suppuration never appears. Our experience with radium also has been that it tends to prevent suppuration. Not only may one mistake infection for suppuration about the third or fourth day after operation, but frequently, if one is not in a hurry to incise the gland, drainage from Stenson's duct may take place to relieve the condition.

Blair and Padgett, in 1923, reported twenty-five cases of secondary parotiditis, thirteen of which occurred post-operatively. Of these thirteen cases, surgical drainage was instituted in nine; seven of the patients died, giving a mortality rate in the thirteen cases of approximately 54 per cent. Paget, in 1886, reported seventy-seven cases of secondary parotiditis, twenty-eight of

which occurred post-operatively. In these twenty-eight cases, surgical drainage was applied in fourteen, and thirteen patients died, a mortality rate of approximately 46 per cent. for the series. Fisher, in 1923, reported six cases of post-operative parotiditis with two deaths; in four of the cases the glands were drained surgically. In the fifty-eight cases from the records of The Mayo Clinic in which treatment by radium was not given and in which accurate records could be found, twenty-three of the patients died. Surgical drainage was applied in the twenty-four cases in which suppuration occurred, and fourteen of these twenty-four patients died, giving a mortality rate of 50 per cent.

In many cases in which parotiditis follows some operative procedure, death is due to the primary lesion, or, possibly, to some other complication. In commenting on this point, one of the earliest observers, Paget, in 1887, in a study of 101 cases, of which twenty-eight occurred post-operatively, wrote: "But out of these thirty-seven who died, three were over eighty years of age, three had internal cancers, one had perforation of the bowel, two had strangulated hernia, seven had undergone very severe operations, involving abdominal section, and thirteen died of septicemia or pyemia. If we add to these deaths one from infantile syphilis, one from marasmus, one from heart disease, we shall see that these thirty-seven patients did not die from parotitis, but from the primary lesion or some form of blood-poisoning after it. Thus, it is not possible to say how far this form of parotitis is in itself dangerous; the danger lies not in it but in the primary lesion." Of the more recent observations, those of Blair and Padgett may be cited. In the fourteen cases of post-operative parotiditis reported by them, seven patients died. However, in only three of these cases could the parotiditis be considered the primary cause of death.

In order to get a fair conception of the mortality rate in regard to this complication following operation, we reviewed, as a group, seventy-nine cases of post-operative parotiditis reported in the literature. In these seventy-nine cases, there were thirty-six deaths, by far the majority of which followed abdominal operations.

In the tabulation are listed forty-nine of the cases from The Mayo Clinic, in which parotiditis followed major surgical procedures and in which radium was not used. It is easily seen from this tabulation that the more serious the operation, the more unhappy is the prognosis when post-operative parotiditis develops. For instance, there were three cases of unilateral, suppurative parotiditis following resection of the colon, with two deaths, whereas there were two cases of bilateral, suppurative parotiditis following pelvic operations, with no deaths.

The question as to whether the infection is unilateral, or invades both parotid glands, necessarily has some bearing on the mortality, since the massiveness of the infection and the multiple foci invariably influence prognosis. There were sixteen cases of bilateral parotiditis, with nine deaths, a mortality rate of 56 per cent., whereas in thirty-three cases of unilateral parotiditis, there were only twelve deaths, a mortality rate of approximately

## POST-OPERATIVE PAROTIDITIS AND RADIUM

36 per cent. By referring to the tabulation, it is readily seen that of the twenty-two cases in which suppuration was present, the mortality was excessively high; thirteen patients, or approximately 60 per cent., died. In the seventy-eight cases from The Mayo Clinic, which have been reviewed, fifty-eight of the patients were not treated with radium, and of these twenty-three died, a mortality rate of approximately 39 per cent., which compares favorably with the mortality rates reported by other observers.

By using radium, and particularly by its immediate application within one or two hours following beginning of the swelling in the region of the parotid gland, we have been able, by reduction of the incidence of suppuration and absorption, to decrease noticeably the morbidity and the mortality. To be most advantageously employed, radium must be applied as soon as the first symptom of parotiditis appears. In our cases, as soon as we began to observe the satisfactory results from the use of radium, we attempted to apply it at the very earliest possible moment; regardless of the time of day or night that a swelling of the parotid gland appeared post-operatively, radium packs were used. The technic of treatment varies somewhat with the severity of the disease, but, ordinarily, a large dose is not necessarily more effectual than a dose of medium size. The maximal dose administered was four applications, eight hours in duration, at intervals of eight hours, of four 50-milligram tubes of radium. Filtration was through two millimetres of lead, one millimetre of brass, and 0.5 millimetre of silver; the distance was 2.5 centimetres and the total milligram-hours 6605. The minimal dose used was two applications, eight hours in duration, at intervals of eight hours, of two fifty-milligram tubes of radium. Filtration was through the same materials as those used in the maximal dose. The total dosage was 800 milligram-hours.

For the first twenty-four to forty-eight hours, there is no appreciable change in the symptoms. The swelling may be extreme, and the temperature  $102^{\circ}$  to  $103^{\circ}$  F.; the toxemia may be severe, and the patient may even become somewhat irrational. However, after the first twenty-four to forty-eight hours, in the average case, there is usually rapid improvement. The swelling remains more symmetrical, and definite lobulation does not appear in the gland. There is no tendency toward suppuration. The temperature approaches normal, and the toxemia rapidly disappears. Usually, in the less severe cases, only a small swelling remains after the fifth day, and the patient is able to take nourishment and feels well.

Of the twenty cases treated with radium, in only two was it necessary to substitute surgical drainage. This, we believe, is the most important point in favor of the use of radium. As has been stated, Blair and Padgett instituted surgical drainage in about 70 per cent. of their cases of post-operative parotiditis, and Paget in 50 per cent. In our cases, before the use of radium, we employed surgical drainage in 50 per cent.

In the fifty-eight cases in which radium was not used (see table), as has been said, twenty-three of the patients died, a mortality rate of approximately 39 per cent. Of the twenty patients treated with radium, only four died. Two of these deaths occurred two weeks and one month after the parotiditis



had completely subsided and can be definitely excluded; death in these two cases was due to pyelonephritis and uræmia, respectively. In another case at necropsy the primary cause of death was found to be a retrosigmoidal abscess, and in the fourth case no cause was found to explain the death except general weakness and the parotiditis. This gives a mortality rate in the cases treated with radium of only 5 per cent. if three cases can be excluded.

These good results naturally incited us to some attempt to explain the mechanism of the action of radium. Desjardins, who, in 1930, reviewed the literature on the beneficial effects of radium and Röntgen-ray in inflammatory conditions such as furuncle, carbuncle, pneumonia, trachoma and erysipelas, concurs in the opinion that the direct action of the rays on the infiltrating leucocytes, rather than the direct action of the rays on the infecting organism, probably is responsible for the satisfactory results.

Desjardins stated that Heineke was the first to establish the exceptional sensitiveness of lymphocytes to Röntgen-rays and radium. He exposed animals to large doses of radiant energy and found that they invariably died.

*Forty-nine Cases of Post-operative Parotiditis Treated without Radium*

Operations	Unilateral				Bilateral			
	Simple		Abscessed		Simple		Abscessed	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
On pelvis . . . . .	5		3		1		2	
Colostomy . . . . .	2		1	1	1	1		
Resection of colon . . . .	4	1	3	2	1	1	2	1
On stomach . . . . .	1	1	2	2			1	1
On gall-bladder . . . . .	3	1	3	2				
Enterostomy . . . . .	1						3	2
On kidney . . . . .	1							
Multiple operations . . . .	1				2	1		
On bladder . . . . .	1	1					2	2
On ruptured appendix . . .	2	1			1			

He observed, at necropsy, that although the majority of the organs appeared normal, the spleen, lymph-nodes and lymph follicles throughout the body gave evidence of marked destruction of lymphocytes. This disintegration of the lymphocytes was found to take place within two hours after the animals had been exposed to irradiation. Desjardins stated that the observations of Heineke have been fully confirmed by numerous experimenters. Warthin found that the lymphocytes showed signs of disintegration even within fifteen minutes after exposure of the animals to the rays.

From the time of Cohnheim, it has been thought that lymphocytic infiltration is one of the most important steps in the natural defense of the organism against infectious processes. How, then, may the apparent benefit of radium in infectious processes be explained on the basis of the destruction of the leucocyte? Commenting on this point, Desjardins stated that he has never seen any harm come from the irradiation of these inflammatory



## POST-OPERATIVE PAROTIDITIS AND RADIUM

processes. He further expressed the belief that through disintegration of the lymphocyte, valuable protective antibodies are liberated which tend to neutralize toxic products of the infective organisms.

A review of our own cases, then, and a comparison of the end-results following the use of radium and other therapeutic agents in the treatment of post-operative parotiditis leads us to the conclusion that the application of radium greatly reduces the incidence of suppuration and thus influences markedly the mortality rate.

### BIBLIOGRAPHY

- <sup>1</sup> Bachrach, R.: Ueber post-operative Parotiditis. *Beit. z. klin. Chir.*, vol. lxxviii, pp. 667-668, May, 1912.
- <sup>2</sup> Barrow, J. V.: Pneumococcal Parotitis. *Jour. Am. Med. Assn.*, vol. lxxviii, p. 1680, June 9, 1917.
- <sup>3</sup> Beckman, E. H.: Complications Following Surgical Operations. *Coll. Papers Mayo Clinic*, vol. v, pp. 777-788, 1913.
- <sup>4</sup> Blair, V. P.: Septic Parotiditis. *Med. and Surg.*, vol. i, pp. 34-37, March, 1917.
- <sup>5</sup> Blair, V. P., and Padgett, E. C.: Pyrogenic Infection of the Parotid Glands and Ducts. *Arch. Surg.*, vol. vii, pp. 1-36, July, 1923.
- <sup>6</sup> Bowe, Edward: Parotiditis Following Appendectomy. *ANNALS OF SURGERY*, vol. xlii, pp. 735-737, 1905.
- <sup>7</sup> Brodie, B. C.: Inflammation of the Parotid Gland and Salivary Fistula. *Lancet*, vol. xxiii, pp. 450-452, December 20, 1834.
- <sup>8</sup> Bucknell, R. T. H.: The Pathology and Prevention of Secondary Parotiditis. *Lancet*, vol. ii, pp. 1158-1164, October 21, 1905.
- <sup>9</sup> Claisse, Paul, and Dupré, Ernest: Étude anatomo-pathologique de quelques cas de parotidite. *Bull. Soc. anat. de Par.*, vol. lxxix, pp. 32-38, January, 1894.
- <sup>10</sup> Claisse, Paul, and Dupré, Ernest: Les infections salivaires. *Arch. de méd. expér. et d'anat. path.*, vol. vi, pp. 250-277, 1894.
- <sup>11</sup> Collins, C. N.: Parotiditis as a Post-operative Complication. *Surg., Gynec., and Obst.*, vol. xxviii, pp. 404-407, April, 1919.
- <sup>12</sup> Cope, V. Z.: Acute Necrotic Parotiditis. *Brit. Jour. Surg.*, vol. vii, pp. 130-133, 1919.
- <sup>13</sup> Cribb, A. J.: The Connexion Between the Parotid Glands and the Generative Organs. *Lancet*, vol. i, pp. 227-228, January 30, 1886.
- <sup>14</sup> Desjardins, A. U.: Röntgen-ray Treatment in Certain Benign and Inflammatory Conditions. *Indianapolis Med. Jour.*, August, 1929.
- <sup>15</sup> Dyball, Brennan: A Fatal Case of Secondary Parotitis. *Brit. Med. Jour.*, vol. i, pp. 1012-1013, April 30, 1904.
- <sup>16</sup> Fenwick, W. S.: The Prevention of Parotitis During Rectal Feeding. *Brit. Med. Jour.*, vol. i, p. 1297, May 29, 1909.
- <sup>17</sup> Fisher, W. H.: Post-operative Suppurative Parotitis. *ANNALS OF SURGERY*, vol. lxx, pp. 713-723, December, 1919.
- <sup>18</sup> Fisher, W. H.: Post-operative Infective Parotiditis. *ANNALS OF SURGERY*, vol. lxxviii, pp. 568-571, November, 1923.
- <sup>19</sup> Fisher, W. H.: The Treatment of Post-operative Suppurative Parotiditis. *ANNALS OF SURGERY*, vol. lxxxvi, pp. 445-448, September, 1927.
- <sup>20</sup> Frank, Jacob: Secondary Parotitis Following Operations for Appendicitis. *Surg., Gynec., and Obst.*, vol. xiv, pp. 469-472, May, 1912.
- <sup>21</sup> Hewitt, A. W.: Bilateral Intermittent Swelling of the Parotid Gland Due to Infection of Steno's Ducts (Sialodochitis). *Jour. Michigan State Med. Soc.*, vol. xii, pp. 664-665, December, 1913.
- <sup>22</sup> Paget, Stephen: Parotitis After Injury or Disease of the Abdomen or Pelvis. *Brit. Med. Jour.*, vol. i, p. 332, February 12, 1887.

## POST-OPERATIVE CORONARY OCCLUSION

By OSMER S. RANDALL, M.D. AND THOMAS G. ORR, M.D.

OF KANSAS CITY, KANSAS

FROM THE SURGICAL CLINIC OF THE UNIVERSITY OF KANSAS

IN 1910 Osler<sup>1</sup> correlated the clinical and pathological findings in occlusion of the coronary arteries. Two years later Herrick<sup>2</sup> described the clinical syndrome clearly and really stimulated modern interest in the subject. Coronary thrombosis as a post-operative complication has apparently received very little consideration. Wilson<sup>3</sup> mentions one case of coronary embolism in a review of forty-seven cases of post-operative embolism. This followed a gastroenterostomy for chronic duodenal ulcer. Neuhof and Aufses<sup>4</sup> have recently studied the cause of death after operation in eight hundred consecutive autopsies in three New York Hospitals. In this series there is no reference to coronary occlusion. Balfour<sup>5</sup> reviewed fifty-one deaths following operations on the stomach and duodenum, one of which he has listed as due to coronary thrombosis. Herrick<sup>6</sup> mentions one death following cholecystectomy. Apparently the condition has not interested surgeons to any great extent. Even those surgeons who have discussed at some length "the acute abdomen,"<sup>7,8</sup> do not give acute coronary occlusion as a factor in differential diagnosis. Their medical confreres, however, have been keenly aware of its importance in the diagnosis of upper abdominal pathology, especially when it is to be differentiated from gall-stone colic, perforated gastric ulcer and acute pancreatitis. The "acute indigestion," so commonly spoken of in the lay press as a cause of death, is probably, in a high percentage of cases, due to coronary thrombosis.<sup>9</sup>

Following are reports of two cases of coronary occlusion following operation, occurring in the Surgical Clinic of the University of Kansas.

CASE I.—H. A. V., male, age fifty-eight, was admitted to the Hospital March 25, 1916, complaining of a double inguinal hernia. There was nothing important noted in the past history, except attacks of palpitation of the heart. Positive findings on examination were overweight, artificial eye, pyorrhœa, chronic tonsillitis, irregular pulse with extra systole every three to six beats, blood pressure 160 systolic and 110 diastolic. The urine showed albumin and a few hyaline casts. There was a definite inguinal hernia on each side and hydrocele on the left. The blood count and hæmoglobin were normal.

With beta-eucain one-quarter of one per cent. as anæsthetic, a left herniorrhaphy and hydrocele excision were done. Before the operation was finished, evidence of beta-eucain poisoning manifested itself by profuse perspiration, slow pulse, and slow irregular respiration. For twelve hours he had continued respiratory distress, slow, weak pulse and at times Cheyne-Stokes type of breathing. During this time he was given adrenalin and intravenous salt solution. He apparently recovered from the poisoning and the next day was making normal post-operative progress.

On the fourth post-operative day about 1:40 A.M., he raised himself slightly in bed to take a drink of water when he suddenly fell back on his pillow, took four or five stertorous gasps and died.

## POST-OPERATIVE CORONARY OCCLUSION

The pathological report by Dr. R. H. Major is in part as follows:

Heart: "On opening the pericardial cavity there is an excess of clear, straw-colored fluid present. The pericardium is smooth and glistening. The heart weighs 560 grams. There is a marked dilatation of the right ventricle. The wall of the right ventricle measures four millimetres in thickness. The wall of the left ventricle measures one and four-tenths centimetres in thickness. Heart valves are normal. The musculature on section has a distinct brownish appearance. The right ventricle shows numerous small, reddish, pin-point areas just beneath the pericardial covering. The aortic arch shows numerous small atheromatous patches. The opening of the right coronary artery just as it passes out of the aorta shows a complete plugging with yellowish white material. On dissecting out the right coronary artery the main trunk and small branches are found plugged with an embolus and the lumen entirely obliterated."

CASE II.—Y. P., a male, age sixty, was admitted to the Surgical Clinic of the University of Kansas December 19, 1929, complaining of pain in the epigastrium. Three months before admission he had received an injury to his upper abdomen by being suddenly jerked by the handle of a road grader. This caused him to have a sudden pain in his epigastrium, as if something had been torn. Since that time he has had more or less soreness and discomfort in the epigastric region, and has been unable to work. At the time of the accident he was somewhat short of breath but this has disappeared. He gave a history of an umbilical hernia for several years. There was some doubt about a small epigastric hernia following the injury. It was thought best, under the circumstances, to repair the umbilical hernia and explore the upper abdomen to determine if there was a small hernia through the fascia or a rupture of the rectus muscle. General examination revealed no other evidence of disease, except arteriosclerosis. His blood pressure was 95 systolic and 60 diastolic. There was a history of treatment for syphilis a few years ago.

December 20, 1929, a midline incision was made above the umbilicus and the upper abdomen explored. No definite hernia was found through the fascia, although there appeared to be some separation of the fibers of the anterior sheath of the rectus muscles. There was a definite diastasis of the recti muscles above the umbilicus. The umbilical hernia was repaired and the wound closed as usual. Following the operation, his condition was satisfactory except slight delirium which was attributed to amytal. He frequently attempted to get out of bed when there was no one to watch him. On the sixth post-operative day an infection was evident in his wound, with a temperature as high as 103 degrees. This was superficial and was easily drained, and the temperature dropped promptly.

On the eleventh post-operative day, he suddenly awoke with rapid respiration and gasping for breath. He did not complain of pain. The pulse was 100 and regular but rather weak. The blood pressure was 88 systolic and 50 diastolic. There was no cough or evidence of disturbance in the lungs. His color was ashen gray and he appeared quite ill. That day the temperature rose to 103 degrees. The respiration varied from 28 to 35 and was suggestive at times of Cheyne-Stokes type. His skin felt clammy. Examination of the heart and lungs did not reveal any definite pathology except distant, feeble heart sounds. The day following the onset of this trouble, a definite to and fro friction rub was discovered over the heart. The heart sounds were more faint than the day previous. His blood count showed a leucocytosis. A diagnosis of coronary occlusion was made. On the third day, the friction rub disappeared and was not heard again during his illness. For the first two or three days he appeared to be entirely conscious and answered questions rationally. Mental disturbance gradually developed. On the fourth day, following the accident, he became quite cyanotic with Cheyne-Stokes respiration and delirium. Abdominal distention was marked. He had a bilateral positive Babinski and ankle clonus at this time and it was thought he had developed emboli in his brain. On the sixth day it became evident that he was developing a hemiplegia. On one occasion he was quite maniacal and had to be held in bed. He had incontinence of faeces and urine. During his entire illness he had more or less cyanosis. A generalized

œdema developed which grew more marked till death. Evidence of general cerebral emboli gradually developed. His systolic blood pressure varied from 100 to 130. On various occasions electrocardiograph tracings showed nothing diagnostic. He gradually grew worse, and died on the fourteenth day following the accident. A final diagnosis of coronary occlusion and cerebral embolism with hemiplegia was made. Autopsy was not permitted. The immediate cause of death was apparently broncho-pneumonia.

The symptoms of coronary occlusion as given by Dr. Louis Hammon<sup>10</sup> are as follows: "1. The immediate symptoms associated with the occlusion; the anginal seizure: A. Pain; B. Shock; 1. Prostration; 2. Fall in blood pressure; 3. Suppression of urine.

"2. The symptoms associated with the myocardial damage, myocardial insufficiency: A. Dyspnea; B. Passive congestion; 1. Cyanosis; 2. Pulmonary œdema; 3. Enlarged liver; 4. Albuminuria; 5. Subcutaneous œdema; C. Cheyne-Stokes breathing; D. Feeble cardiac impulse, faint heart sounds, gallop rhythm, murmurs, cardiac arrhythmias.

"3. The symptoms associated with the myocardial infarct: A. Fever and leucocytosis; B. Pericarditis; C. Embolic phenomena; D. Cardiac aneurysm and rupture.

"4. Additional symptoms: A. Nausea, vomiting, diarrhoea; B. Facies; C. Vasomotor symptoms; D. Nervous symptoms."

The close association between angina pectoris and coronary obstruction is well recognized and should aid in the diagnosis of the latter condition.

*Discussion.*—The two patients here reported were both males, fifty-eight and sixty years of age. Herrick<sup>2</sup> states that the condition usually occurs in men beyond fifty years of age with arteriosclerosis and previous attacks of angina pectoris. Both of our patients had definite evidence of arteriosclerosis, but neither gave any history of angina pectoris. In one case examination revealed an irregular pulse with what were apparently extra systoles and a blood pressure of 160 systolic and 110 diastolic. Blood pressure in the older man was 95 systolic and 60 diastolic and the pulse was regular.

In Case I the operation was done entirely with local anæsthetic. This was followed by definite evidence of beta-eucain poisoning and death occurred on the fourth post-operative day. In Case II one-half per cent. novocain was used followed by gas oxygen and ether. Wound infection followed. Preliminary to the anæsthetic he received 15 grains of amytal,  $\frac{1}{4}$  grain of morphine and 1/200 grain of scopolamine. Evidence of coronary occlusion occurred on the eleventh post-operative day.

It has been stated by Evans<sup>11</sup> that post-operative thrombosis, in general, manifests itself most frequently at an interval of some days after the operation. Probably, if the tenth day be taken as a central point, a large proportion of the accidents occur within two or three days on either side of that point. He notes that the blood platelets rise following operation, reaching a maximum in about ten days and then declining to normal. After operation there is also a rise in blood-fibrinogen, apparent on the third day and persisting until the tenth day. The increase in these two important elements of clotting

## POST-OPERATIVE CORONARY OCCLUSION

following operation serves to explain why surgical patients may develop thrombosis or embolism about the tenth post-operative day. Our Case number II conformed to this rule. We see no reason why this explanation of Evans's should not apply to post-operative coronary thrombosis as well as such pathology elsewhere in the body.

We have no definite explanation to offer for the development of occlusion of the coronary arteries in these cases, other than possibly a thrombosis engrafted upon a preëxisting arteriosclerosis. The beta-eucain poisoning with its accompanying slow pulse and drop in blood pressure in the first case, and the infected wound in the second case, may have been contributing factors. These two cardiac accidents suggest the importance of a close pre-operative heart study, including a careful history concerning the occurrence of anginal symptoms. Such a history was not sought in our cases nor did the patient volunteer any such information.

It might be possible in certain cases to avoid post-operative catastrophe by taking a careful history of the heart condition and by making electrocardiographic studies, especially in patients over fifty years of age with arteriosclerosis. The work of Walters<sup>12</sup> should be noted when considering the prevention of thrombosis following operation. In order to combat the decrease of metabolism, the decrease in blood pressure and the slowing of circulation he has given tablets of desiccated thyroid gland in doses of two grains three times daily. With this treatment he reports a decrease in the frequency of pulmonary embolism.

Bancroft, Kugelmass and Stanley-Brown<sup>13</sup> believe that diet has a definite influence upon the clotting function of the blood. Mills<sup>14</sup> emphasizes the important relation of food intake to coagulability. Coagulability is increased with a protein diet and decreased with carbohydrates and fats. He calls attention to the fact that the platelet count rises just at the time most patients are allowed to begin mild exercise and take a full diet. There is a period when all factors favoring thrombosis are at a maximum; the platelets are greatly increased; increased protein intake increases their tendency to clump and disintegrate; this is further aided by the exertion and moving around, and finally the action of the sluggish circulation is intensified during the first few days of sitting up or getting out of bed.

### CONCLUSIONS

In the pre-operative study and examination of males past the age of fifty, it is suggested that a careful cardiac history be taken to exclude angina pectoris as a predisposing cause of post-operative coronary occlusion.

A fall in the blood pressure following operation may be a contributing factor in the development of coronary thrombosis. Every effort should be made to prevent shock by proper selection of anæsthetic and operative technic.

Patients having any evidence of coronary disease should be treated with thyroid gland and careful regulation of diet until the danger period has passed.



## RANDALL AND ORR

### BIBLIOGRAPHY

- <sup>1</sup> Osler, Wm.: Angina Pectoris and Allied States. D. Appleton & Co., 1901.
- <sup>2</sup> Herrick, J. B.: Clinical Features of Sudden Obstruction of the Coronary Arteries. Jour. Am. Med. Assn., vol. lix, p. 2015, Dec., 1912.
- <sup>3</sup> Wilson, L. B.: Fatal Postoperative Embolism. ANNALS OF SURGERY, vol. lvi, p. 809, 1912.
- <sup>4</sup> Neuhof, Harold and Aufses, Arthur H.: Causes of Death after Operation. ANNALS OF SURGERY, vol. xci, p. 321, Mar., 1930.
- <sup>5</sup> Balfour, D. C.: Report of Surgery of the Stomach and Duodenum in the Mayo Clinic for 1929. Proceedings of Staff Meetings of the Mayo Clinic, vol. v, p. 64, Mar., 1930.
- <sup>6</sup> Herrick, J. B.: Atypical Features of Acute Coronary Occlusion. Ann. Int. Med., vol. iii, p. 105, Aug., 1929.
- <sup>7</sup> Cope, Zachary: The Early Diagnosis of the Acute Abdomen. Oxford University Press, 3rd edition, 1926.
- <sup>8</sup> Deaver, J. B.: The Acute Abdomen. Surg. Gynec. & Obst., vol. xxxix, p. 744, Dec., 1924.
- <sup>9</sup> Coffen, T. H. and Rush, H. P.: "Acute Indigestion" in Relation to Coronary Thrombosis. Jour. Am. Med. Assn., vol. xci, p. 1783, Dec., 1928.
- <sup>10</sup> Hamman, Louis: The Symptoms of Coronary Occlusion. Bul. Johns Hopkins Hosp., vol. xxxviii, p. 273, 1926.
- <sup>11</sup> Evans, W. H.: Discussion of Postoperative Thrombosis. Proc. Roy. Soc. Med., vol. xxii, p. 729, Nov., 1929.
- <sup>12</sup> Walters, Waltman: Method of Reducing the Incidence of Fatal Postoperative Pulmonary Embolism. Surg., Gynec. and Obst., vol. l, p. 154, Jan., 1930.
- <sup>13</sup> Bancroft, F. W., Kugelmass, J. N., and Stanley-Brown, M.: Evaluation of Blood Clotting Factors in Surgical Diseases. ANNALS OF SURGERY, vol. xc, p. 161, Aug., 1929.
- <sup>14</sup> Mills, C. A.: Relation of Protein Diet to Thrombosis. ANNALS OF SURGERY, vol. xci, p. 489, Apr., 1930.

## LYMPH EXUDATE AND FIBROUS TISSUE\*

By EDWARD T. CROSSAN, M.D.

OF PHILADELPHIA, PA.

ASSOCIATE SURGEON, EPISCOPAL HOSPITAL

"The artless songs I sing do not deal with anything new or never said before."

THESE words of Rudyard Kipling are particularly fitting to the topic for this annual address. As the results of inflammation, lymph exudate and fibrous tissue remain today almost as great problems for the surgeon as they were when the processes of inflammation were described by Cohnheim in 1877. Nor do I have any new tales to add to those already told. The object of the discourse is to consider in detail the surgical application of the tales heard before about these tissues.

In surgery, fibrous tissue is an expression of recovery or it is the termination of irritation. To the patient, this scar tissue bears a sort of political relationship, for there are occasions when it is a mighty factor as an ally in the restoration of health, and, just as frequently, it can be found as a determined irresistible opponent to the restoration of function. Without this tissue, surgery would be impossible, and because of it surgery often is impossible.

As a process of repair and a medium for reconstruction, fibrous tissue is indispensable. Every wound, regardless of whether it is closed surgically or heals by granulation, depends upon fibrous tissue for the restitution of its structures or its coverings; in some wounds it provides strength, and in others it furnishes a scaffold for the growing epithelium or endothelium. For the restoration of function, fibrous tissue at times gives up its identity entirely, as, for example, in reconstruction operations fibrous tissue may become converted into cartilage, or in tenorrhaphies it takes on the shape of tendon. Then, too, in other reconstruction operations, fibrous tissue in the form of living sutures reproduces itself to restore anatomy.

Even in its disabling manifestations, fibrous tissue has had its inception for a beneficent purpose. Only in exceptional instances, as in keloid and certain cases of abdominal adhesions, have the reparative forces of the body run wild without undue cause. Many of the other deformities represent the body's efforts to repair destroyed tissue, and we have come to look upon these deformities as the toll the patient must pay for a fibrous tissue reaction to an excessive irritation. It is even possible that, after infections, some surgeons look upon the disabling fibrous tissue as a tribute to their art, in other words, the deformity to them is a proof of a violent contamination which has been cured by surgical procedures.

---

\* The Annual Address before the Philadelphia Academy of Surgery, May 5, 1930.

To cure or improve is the primary object of surgery, but to cure or improve without deformity and disability is the ideal of surgery. Lymph exudate is a vital element in all surgical cures, both as a defensive mechanism and as the progenitor of fibrous tissue. Thus the problem is to control lymph exudate so that there may be cures with fibrous tissue as reparative as in the closure of wounds or in reconstructions. Viewed in this light, we may discover that many deformities are not tributes to surgery, and we will observe that a combination of a woman's touch and other qualities are not the only attributes of a good surgeon. Furthermore, if the surgeon appreciates the qualities of lymph exudate and fibrous tissue, he will understand how to deal with those deformities which have not or cannot be controlled.

My first practical lesson in lymph exudate occurred several years ago, and, though I have mentioned the instance at a previous meeting of this Academy, a repetition of the details still contains a lesson. The patient, a young girl, had weathered an attack of peritonitis of appendiceal origin, only to be faced a few days later by probable death from intestinal obstruction. In spite of morphine, lavage, and abstention from even liquids, the symptoms progressed. I reopened the abdomen and found coils of small intestine matted together in the pelvis and in the right iliac fossa by silvery membranes of exudate. Very carefully and thoroughly, I separated the films, saw the intestines resume their size and closed the abdomen with an absolute confidence that the obstruction was controlled. On the day following the second operation the patient again developed obstruction, on account of which I was forced to open the abdomen a third time. At the third operation, the intestinal coils were found matted together once more, but this time I showed better sense and performed an enterostomy, as the result of which the patient entirely recovered. My error at the second operation consisted in judging those membranes only as mechanical barriers, that is, I failed to think in terms of lymph exudate.

Lymph exudate is the body's first reaction to irritation, be it physical, chemical or bacterial. In the case just cited, if I had remembered this fact, I could have prognosticated the formation of more lymph exudate because the digital separation of the membranes was just another irritant. There is no operation, nor any infection which does not irritate the tissue, and in turn the tissues neutralize the irritant and repair the damage by the formation of lymph exudate. This defensive and reparative mechanism is not alone the pathologist's problem; surgical neglect of it is equivalent to thinking that sutures heal a wound or that drains and antiseptics cure infections, in short, it is the practice of mechanical surgery. The disciples of this school, not so many years ago, in peritoneal infections, were tearing away this defensive mechanism, the membrane which, as Boyd and others have said, "is more offensive to the surgeon's eye than to the patient's tissues." Nor is it necessary to carry on experiments to confirm this statement; a study of the components of the exudate will afford ample corroboration.

## LYMPH EXUDATE AND FIBROUS TISSUE

What are the constituents of the local reaction to irritation. Leucocytes, yes, leucocytes, and serum, fibrin, macrophages and monocytes—each a separate element but all acting in concert. The leucocytes phagocytose and liberate thrombin. The serum through the antitryptic element prevents any digestion of the tissues that would furnish nutriment to bacteria; also, serum brings opsonins, agglutinins, precipitins and fibrinogen, the latter to unite with thrombin for the formation of fibrin. Fibrin offers a foothold for the leucocytes, it shuts off absorption through lymphatics and, figuratively speaking, it ties the bacteria into knots. When the storm of irritation has passed away, the fibrin remains as a focus for the macrophages, leucocytes and monocytes to nourish and produce fibroblasts; in aseptic irritation Hertzler believes that the fibrin is actually converted into fibrous tissue. Taking infection as a specific example of irritation, we find that the exudate starves the bacteria, impedes their action or destroys them and prevents their toxins from entering into the circulation. What can a surgeon hope to add to such a defense? Obviously, only those measures which will nurture and stimulate the exudate.

However, the common practice of treating infections is based on an utter disregard for fibrin, leucocytes and serum. Pus to most surgeons seems to be an indication that the body defenses have broken down. Here, they say, we will destroy these bacteria by antiseptics, by frequent change of drains or by irrigation. What else do they destroy? Naturally, the defense mechanism, because anything that will kill the bacteria must also kill the white blood cells. If chemicals would kill organisms, one could afford to neglect the exudate. Does an antiseptic sterilize an infected wound?

Sir Almoth Wright has said, "If ever an antiseptic sterilized a heavily infected wound, that would deserve to be announced in all the evening and morning newspapers." Wright's inferences can be confirmed by daily visits to any hospital at the dressing hour. You will see pus pour forth from the same infected wounds day after day in spite of the use of varied antiseptics widely advertised as having a high phenol coefficient. If antiseptics are of value, it would seem reasonable that the abscess cavity should be sterilized when the incision is made, yet rarely is this done. Both Wright and Fleming have shown by experiments on wounds and in test tubes that (1) antiseptics cannot reach the bacteria in the tissue spaces; (2) antiseptics are rapidly diluted by the tissue juices to a point where they are no longer lethal for bacteria; and (3) antiseptics will not act in the presence of sloughs, and have very little action in serous discharges or in the presence of blood.

Antiseptics in infected wounds are not only useless but they are harmful. The destruction of leucocytes by the chemicals is not theoretical. Fleming, in 1919, showed that, with most of the antiseptics then in vogue, leucocytes were destroyed or their emigration inhibited. Fleming also demonstrated that some antiseptics actually increased the growth of bacteria, probably because the trypsin from the dead leucocytes encouraged digestion. The cure of an infection by the use of antiseptics is more

probably due to a generous incision than to a destruction of bacteria. It is possible that more recoveries and less loss of tissues from infections might be procured if surgical procedures did not destroy the defensive exudate.

Since the destruction of bacteria is not feasible, let us return to the proposition that protection and stimulation of the exudate are the rational procedures. Incision, drainage and infrequent change of drains—these measures are the only additions that a surgeon can hope to add to the body defenses. This passive method Wright has called the physiological treatment. Fleming has shown that there is one exception to this rule of treatment, namely, in the flat infected wounds. In this variety of infection a preliminary irrigation by hypertonic salt followed by eusol sterilizes the wound; the salt solution washes away the albuminous material and establishes a watery medium, the best medium for the action of antiseptics; the character of the wound permits the eusol to reach every crevice.

For years, surgeons have been forced to follow the physiological line of treatment in infections of the peritoneum. It is admitted by even the champions of antiseptics that no solution can reach all the recesses within the abdomen. No surgeon would think of using an irritant within the abdomen for fear of destroying endothelium, thereby increasing the absorption of toxins. Morphine, Fowler's position and nothing by mouth might cure some cases of peritonitis, but not many. Passive resistance by incision and undisturbed drainage, in conjunction with the measures noted, gives a high percentage of cures, if the treatment be inaugurated before the body has been overwhelmed by toxins. Here, in one of the most sensitive tissues of the body, are afforded daily examples of the efficacy of the passive treatment of infections.

Passive is not an exact qualifying term to apply to the physiological treatment because the method is actually stimulating and irritating to the lymph exudate. The fundamentals of the treatment, the incision and drainage, are more than mere mechanical procedures. The incision relieves pressure (Devine calls it detensionizing), and there is a resultant transudation of serum, an emigration of leucocytes and a backwash from the lymphatics. The drain, though it is inserted as a means for the egress of pus, also actually stimulates the formation of an additional defense. Let us consider in detail the subject of drains and their relation to lymph exudate.

Paradoxical as it may seem, the excretions from many a drained wound, excepting the discharges of the first twenty-four hours, actually are made possible by the closure of the drain with lymph exudate. Remove from your mind entirely the thought that the drain conveys pus and instead consider the drain in its true nature, a foreign body. Any foreign body introduced into a tissue space is an irritant which Nature in a very few hours surrounds by lymph exudate. If the entire circumference of the drain be in contact with tissue there is formed a channel through which pus reaches the surface. Consequently, lymph exudate can make of a drain, to use the words of Marion Sims, "a plug to keep the wound open." Of course, these state-



## LYMPH EXUDATE AND FIBROUS TISSUE

ments, and those which follow, do not apply when fibrin actually penetrates the substance of the drain.

Now, let us revert to the thought that a drain creates an additional defense; that is, it does something more than prevent pus accumulation. In order for you to get a clear conception of this function, think first of an infection and picture to yourself the central cavity of pus surrounded by Nature's barrier of fibrin, leucocytes, *etc.* Introduce into that pus cavity a drain and then recall to your mind how the drain is excluded by lymph exudate. Now, you should have a mental picture of a wall within a wall or of a lymph exudate ring within a lymph exudate ring. Thus, the drain has been the cause for more fibrin and thereby the lymphatics have been more effectively occluded. Also, the more fibrin there is, the greater will be the surface for leucocyte attachment, consequently the more effective will be the phagocytosis, because leucocytes must be fixed to phagocytose. The addition of fibrin and leucocytes are not the only stimulants to the defense by the drain; there is also a constant out-pouring of serum as long as the drain is in the wound, a phenomenon that Horsley has termed a reversal of the lymphatic circulation. Arguments as to the relative merits of a drain are mere academic exercises when compared to a detailed knowledge of the relation of the drain to the lymph exudate.

Some one has said that it is easier to act than to think, a saying that is pertinent to the subject of drains and lymph exudate. For years and years drains have been pulled out of infected wounds daily without a single thought being given to the fact that fibrin and leucocytes were being destroyed. Mutilation of this defensive barrier results not only in an increased absorption of toxins, but also in a reactivation of the infection. A reintroduction of the drain, it is true, will erect another barrier; also, the re-introduction will kill more leucocytes and destroy more fibrin. The sum of the deleterious effects of pulling out the drain and putting it back will probably be greater than the beneficent results established by Nature in the interim between dressings.

Don't disturb the drain unless absolutely necessary, as has been mentioned, is one of the principles of the physiological treatment of infections. The practice of frequent change of drains is based on the fear that excretions will be dammed up by plugging. Every drain does become plugged, but, if the incision be extensive enough, there is no accumulation of pus; there usually is an increase of excretion through the attempts of the body to extrude the foreign object. If you have ever left packing in a wound for five or six days, or if you have ever seen a forgotten sponge removed from an abscess cavity you know that the foreign body was soft and mushy when removed, and you know that there usually was a profuse discharge until the object was taken out. In peritonitis cases drains are not disturbed and yet there seldom is any accumulation of pus as a result of plugging of the drains. Frequent removal of drains is unwarranted and is just as destructive to lymph exudate as is the use of antiseptics. When the penetration of the

fibroblasts into the lymph exudate imparts a rigidity to the channel, the drain can be changed occasionally or removed gradually without reactivation of the infection and without the production of excessive fibrous tissue.

Finally, in this discussion of drains and lymph exudate, there remains the topic of prophylactic use of drainage in the abdomen. Introduction of a drain to prevent dissemination of leakage is good surgery provided the surgeon realizes that the drain may actually encourage leakage. A drain introduced near the site of an anastomosis will build up additional lymph exudate; it will increase the soggyiness at the stoma and the sutures may pull out. For the same reason, in the closure of perforated ulcers, if the subphrenic space is to be drained, be sure that the drain does not pass near the closure; neglect of this detail may be a cause for an abscess in the area that is being drained. If one is to judge from the literature, this principle has been entirely forgotten in the discussion of the merits of ideal cholecystectomy. Bile on the dressings after cholecystectomy with drainage may as well be an argument against the drain as it is in favor of it, in other words, the drain might have been the cause for the cutting through of the ligature. This subject cannot be dismissed without some mention about the relation of prophylactic drainage to adhesions, and it is in cholecystectomy that the topic has been given considerable prominence. Clinical experience has led me to believe that a drain within the abdomen for forty-eight hours, the period of our use of the prophylactic drain, never causes symptoms. Theoretically, the statement is perfectly plausible, because the lymph exudate formation ceases on removal of the irritant, and, at the end of forty-eight hours, there are comparatively few leucocytes and macrophages to nourish and stimulate fibroblasts. In cholecystectomy with drainage, in addition to the theory just given, there is the fact that the drain is the least of the irritants. The sutures used in the gall-bladder bed, the trauma to the free fold of the gastro-hepatic omentum, the ligatures on the cystic artery and cystic duct, the combination of these irritants produces more lymph exudate than does the drain, and, furthermore, the sutures, ligatures and raw area remain long after the drain has been removed. I doubt very much that the lymph exudate from prophylactic drainage is a major malefactor in the formation of adhesions.

So much for the detailed story of lymph exudate in infections, and as yet it is still a story in this presentation. On paper, in the test tube, and under the microscope it seems reasonable that incision and undisturbed drainage best serve the patient's welfare because they protect and irritate lymph exudate. However, bacteriological and pathological findings are just theories to the surgeon, unless he can prove them clinically. The statement "that is not my experience" is a convincing argument against any theory, an argument that can be contraverted only by examples of application of the theory. What are the clinical experiences with the physiological treatment of infection?

During the World War, Morrison, by the use of B. I. P. P. paste and

## LYMPH EXUDATE AND FIBROUS TISSUE

infrequent dressings, secured results which were said to have been as good as those obtained by any other method. Morrison attributed the effects to some sort of sterilization as a result of the interaction of the paste and the tissue juices; the paste itself had no antiseptic effect; in fact, it had to be sterilized before it was introduced into the wound. Fleming was never able to prove Morrison's theory by experiments in the test tube or in the wound, and he concluded that the good results were due to the infrequent dressings. Furthermore, in 1919, Fleming suggested that some bland substance for the wound packing would give results equally as good as B. I. P. P. Orr has supplied that bland substance in vaseline gauze and has combined it with passive wound treatment more radical than Morrison's. Orr's results have proven that Fleming's deductions were correct.

The physiological treatment of surgical infections, call it the Orr method, or the Morrison-Wright-Fleming-Orr method, gives brilliant results. With a generous incision and a bland greasy substance for wound packing that is not disturbed for ten days or longer, deformities seldom occur after infection. The packing never plugs, and when it is removed there is exposed a healthy, red wound, with little or no pus. Surgeons who have used this treatment know that antiseptics are useless; they have had proof that the ideal cure can be obtained by supporting and controlling lymph exudate.

Orr believes that the good results are due to an absence of re-infection by frequent dressings. If re-infection were probable, it is possible also, that the accumulation of the wound secretions on the skin would re-infect, or that the cast and the thick unchanged dressings would cause a washing into the wound of the skin bacteria by perspiration. It is probably more exact to say that there is no re-activation of the wound infection by trauma to the defenses. Whether it be re-infection or re-activation, the end-result is the same: the excessive irritation leads to excessive lymph exudate and fibrous tissue.

Fibrous tissue is the deforming factor after infections treated aggressively. For instance, in a case of acute osteomyelitis that has been treated by antiseptics, *etc.*, there practically always occurs a sinus which is generally supposed to be due to a continued infection. Look at the sinus and see the inverted skin edges, feel the sinus wall and note its firm consistency, excise the sinus and transplant into the gap a flap of soft parts and see it heal up (as Reid and others have done), and you will be forced to the conclusion that the persisting sinus is due to the fibrous tissue. Or take a sinus in the soft parts after an infection that was treated similarly to the osteomyelitis, and if you strap the sides of that channel together, healing will occur in a few days; the cause for the drainage was due to the fibrous tissue that prevented collapse of the channel. You may well ask, if the sinus in osteomyelitis be due to fibrous tissue, why does sequestration, a remnant of the infection, so frequently occur?

Sequestration and sloughing tendons, we have been taught, are due to a destruction of the blood supply by the infection. When you have seen

cases of acute osteomyelitis heal without sequestration after treatment by the physiological method, you will have reason to doubt that the infection is the only factor in destruction of the blood supply, or even an important factor. Before infection *per se* can be condemned for the sloughing tendons and the sinuses, it must be proven that granulation tissue is blameless. Granulation tissue is known to destroy cartilage and bone in arthritis, and, in spite of the recent reports on parathyroid hyperplasia, it is probably the source of destruction in osteitis fibrosa cystica, local or diffuse. Granulation tissue is in excess wherever there is prolonged infection or irritation; therefore it is excessive in the old method of treating infection. Granulation tissue attached to any structure will shut off, by its bulk, the blood supply to that structure and this is the probable source of bone and tendon destruction after prolonged infections. This statement could be classed as rank heresy were it not for the fact, as previously mentioned, that sequestration and sloughed tendons seldom occur in the physiological treatment; that is, they are uncommon where there is a minimum of irritation and granulation tissue. If further proof be needed, cut away the fibrous tissue and granulation tissue, close the wound so that there will be no further irritation and see the wound heal without sequestration. In terminating this discussion on lymph exudate and its value in infections, let it be noted that skill is not essential to the ideal cures, and that deformities are not an index of the severity of an infection.

The lymph exudate of repair has the same qualities as the lymph exudate of defense. When the storm of infection has cleared away, and, to some extent during the infection, the defensive barrier changes to a reparative medium. The fibrin forms the scaffold for the ingrowing fibroblasts and the sprouting blood-vessels; thus, there comes into existence the granulation tissue. At first, the fibroblasts and the blood-vessels lie parallel to each other and at right angles to the surface of the wound. After organization is completed, the cells and fibrils have changed to a direction parallel to the surface of the wound, the blood-vessels have become obliterated and the cells have shrunk. Whether the fibroblasts spring from fibrous tissue, or from the polyblasts or the monocytes, seems of less practical importance than is the final arrangement of the fibrous tissue bundle.

Every soft pliable scar has the fibroblasts and fibrils arranged parallel to the surface of the scar, whereas, in adhesions and in some contracted scars, the bundles are at right angles to the coverings, the primitive arrangement in healing. Horsley, in his study of cicatricial contractures, came to the conclusion that there were no histological differences between the contracted and non-contracted scar, though he did note that in the contractures fibroblasts were found in an arrangement at right angles to the epithelium. Could it not be that it is just this difference in polarity of the cells that accounts for the tendency of scars in certain regions to contract?

Longitudinal incision in the neck, elbow, hand, axilla and popliteal space—all of them have a tendency to contract, regardless of whether there has



## LYMPH EXUDATE AND FIBROUS TISSUE

been healing by so-called primary intention or healing by granulation. These contractures stand out in whiplike cords and they mechanically impede motion. Inspection of these cords shows that the fascia in the region of the scar is pulled out beyond its surroundings. This traction outwards could be explained by the arrangement of the fibrous tissue bundles at right angles to the skin, an arrangement that would cause the fascia to be pulled up and out when the scar tissue contracted at organization. Why should the bundles have a different arrangement in contractures? Bunting and Eades may have answered this question by their experiments in which they were able to change the arrangement of the fibroblasts by changing the lines of traction on a wound. If they applied traction perpendicular to a wound, fibroblasts assumed that direction; if the traction was parallel to the line of the wound, the fibroblasts were in the same direction; if the forces were radial, the fibroblasts were also radial.

Now, it seems to me theoretically probable that muscle- and tendon-push on the skin determine the contractures mentioned. Feel your own antecubital fossa when the elbow is flexed and you will notice how the biceps tendon stands out like a cord and pushes up the skin. If there were a longitudinal wound in this region and if the elbow were held at a right angle or if it were moved frequently before organization, the fibroblasts would, according to Bunting and Eades' experiment, lie at right angles to the wound, and, after organization, they would pull out the deep fascia into a band. Or, again, abduct your shoulder and note how the axillary fold muscles make a downward traction on the skin of the axilla, and this is another site of web-like bands. I have noted, though it may be a coincidence, that none of the radical operations for carcinoma of the breast have contractures, and I have assumed that this was due to the removal of the axillary fold muscles and to the splinting of the arm against the chest.

What is the practical application of this knowledge of traction? First, of course, use transverse scars in the regions noted. Incidentally, you may wonder why traction does not affect the latter wounds. I believe that it is due to this fact, that the traction or push out in the center of the wound is neutralized by the pull in or transverse pull at both extremities. To return to the applications, incisions are not always surgical, and there are other injuries, such as burns. If traction be a factor in contractures, it would seem reasonable that in destruction of tissue in the axilla, the arm should be held against the side to eliminate the muscle-push and then depend on later stretching of the fibrous tissue to restore abduction. Also, in burns of the chest and neck, immobilization of some sort might prevent motions that make for contractures by taut muscles. When wounds occur longitudinally in the surface flexures, motion should be prohibited until after four or five weeks or until the fibroblasts have become settled in a line parallel to the scar.

The lymph exudate of primary healing requires very little discussion. The sutures and splints we employ insure healing from lymph exudate



through granulation, so that any defect is usually the result of mechanical error. However, there is some profit and considerable mental diversion secured by translating sutures, *etc.*, into terms of lymph exudate.

Every surgeon knows that the best cosmetic result is secured by the use of non-absorbable material. The answer is found in the fact that the absorbable suture is a greater irritant and more of a foreign body than the silk-worm and like materials. Catgut requires more lymph exudate and requires it over a longer period of time because it is not removed, therefore, with these sutures, there will be more fibrous tissue.

In suturing, one should remember that every stitch more than required is a double irritant; first, by means of the extra foreign body, and secondly, through the trauma of introduction of that foreign body. If, as seems probable, purse-string sutures in appendectomy be unnecessary, then the practice of burying the stump should be abandoned, not on account of the change of form in the cæcum, but because of possible fibrosis and adhesions from unnecessary trauma. On the other hand, extra irritation and added trauma might be of advantage, as in herniorrhaphies; here many sutures closely placed will secure a firmer bond between the muscles and Poupart's ligament than will a few sutures. Likewise, close suturing of the abdominal wall is an added protection against prolapse of the intestines or a stretching of the scar. The use of many sutures in gastroenterostomies in order to prevent leakage may be unnecessary. It is probable that leakage would not occur provided the surgeon made use of interpolation—if only one line of sutures were used—because, as Hertzler has demonstrated, the interstices between the sutures are filled with lymph exudate in a few hours. This observation explains the absence of gastric juice leakage after this operation and accounts for the safety of water administration in small amounts by mouth after twelve hours.

The purpose of sutures is to hold firmly the lymph exudate scaffold. The suture material is absorbed or removed before the scaffold has disappeared and before the fibrous tissue has organized. It is in the interim between lymph exudate and fibrous tissue, between suture and organization, that great care is required. This is the period when we must guard not only against what the patient may do, but also against what others might do to the patient. Garlock had this danger period in mind when he advised early active motion and counseled against passive motion following tenorrhaphies. He knew, for instance, that the finger movements would be commensurate to the strength of the exudate bond, whereas the masseur might tear that bridge away.

Every discussion of lymph exudate is more or less intertwined with the subject of fibrous tissue, but a discussion of fibrous tissue does not of necessity involve lymph exudate. Fibrous tissue also springs from blood-clot, a formation in which lymph exudate is a secondary factor. Elimination of blood-clot is another method of fibrous tissue control. Some few years ago, Owen, at one of these meetings, showed some excellent functional re-

## LYMPH EXUDATE AND FIBROUS TISSUE

sults obtained by the frequent tapping of hemarthrosis of the knee. From experience, we all know that blood left in a joint will clot and organize, with the result that there will be impeded motion by the mass, or ankylosis from destruction of the cartilage by granulation tissue. Organization of blood also occurs in the largest endothelial cavity, in the peritoneum, and to leave clots here is an invitation to the formation of fibrous tissue.

Fibrous tissue and lymph exudate are not related problems when the deformities come to the surgeon in full bloom. Then, control is no longer possible; the solution can be secured only by stretching or collapsing the wall. If one attempts forcibly to break up the adhesions, then there ensues another process of granulation and organization.

The treatment of fibrous ankylosis of joints is a prominent example of what stretching can do as opposed to what breaking adhesions will cause. The dramatic procedure of breaking up joint adhesions under anaesthesia is brutal and useless. Reverse Hunter's formula and "think—don't try," and you will never use this method. Breaking up adhesions means bleeding into and around the joints, more fibrous tissue and aggravated ankylosis. Clinically, after these procedures, the joints are swollen and, in the end, the patient has less motion than at the beginning of the treatment. Put these cases on gradual stretching by plaster casts or by traction apparatus and a fairly good functional result will be obtained in many cases.

Stretching of adhesions, a stretching that is persistent, is an occasional cause for disability and pain. I have in mind the adhesions about the subastragalar joint after fracture of the os calcis. The efforts of surgery in this instance are directed against further stretching by abolition of the joint motion through arthrodesis.

Stretching is a big item in the surgery of fibrous tissue; sometimes we use it; occasionally we abolish it, and frequently in abdominal wounds we guard against it by the use of belts. In the abdomen, for fibrous tissue to be truly reparative, it must be a narrow, firm band that joins together gaps in the muscle or fascia or joins muscle and fascia. Where the scar is thin and wide, a belt might be of service if it could prevent lateral traction on the scar, which it rarely does. If the patient be very fat, then the belt does reduce stretching by preventing pressure from the inside. However, to consider the belt as a protection against muscle-pull is a delusion, because when the patient is stooped over, as in the act of lifting, two hands can be inserted between the belt and the belly. For the linear scar, the belt gives comfort to the patient but nothing else, for be it remembered, that these scars become organized in three weeks.

The most efficient treatment of fibrous tissue is that which has for its object the excision of the scar or the collapse of the sinus wall. Already, this treatment has been noted with respect to the sinuses of osteomyelitis, and it is the principle behind thoracoplasty in chronic empyema. Fistula in ano is also a sinus encircled by fibrous tissue; if it were possible to strap the sides of this channel together, healing sometimes would occur without opera-

tion. Incision of the roof of this quasi-fistula results in healing, though delayed healing, by a collapse of one part of the fibrous tissue. Excision of the entire tract and immediate closure of the wound, as is done in Ashhurst's clinic at the Episcopal Hospital, gives a rapid cure, and a union by adhesion in the majority of the cases. The prolonged dressings for many sinuses could be prevented by excision of the entire fibrous tissue barrier.

What about the fibrous tissue riddles of keloid and peritoneal adhesions? Whoever solves keloid will answer the question of tumors and their related subjects of tissue tension, internal secretion, growth and inherited properties. As for abdominal adhesions, it does not seem probable that any substance introduced into the peritoneal cavity will prevent their growth, since even physiological salt solution within the belly is a cause for a leucocyte emigration.

At the end of the scale, I have placed non-union of fracture. Cowan's brilliant work seems to show that non-union is the result of fibrous tissue, and that the fibrous tissue does not represent an attempt at bone repair. By experiments on dogs, and by clinical observation, Cowan came to the conclusion that the fibrous tissue from the periosteum grew between the bone ends because the fragments were separated. This band, he reasoned, grew faster than the medullary callus could fill the gap, and it succeeded in holding the bones apart. Perhaps this difficult complication will be solved by the simple method of excluding the periosteum, as Cowan has done, when operating on cases of non-union.

I might continue for some time this theorizing and recital of old tales, but I fear that I would be committing the error of repetition of details. Details are all I have had to bring you, for which I have, as excuse, the saying attributed to Michelangelo that "success is due to details, but success is no detail."

## METASTASIS OF THYROID TISSUE TO ABDOMINAL ORGANS

WITH SPECIAL CASE REPORT OF A STRUMA OVARII METASTASIZING  
TO THE OMENTUM

By PHILLIP F. SHAPIRO, M.D.

OF CHICAGO, ILL.

FROM THE DEPARTMENT OF PATHOLOGY OF THE COOK COUNTY HOSPITAL

THYROID tissue is found from time to time in places other than its proscribed location in the neck. There are three possibilities for its ectopic occurrence. Vestiges of thyroid anlage may be dropped during embryonic development all the way along the course of the normal thyroid invagination, from the mediastinum to the root of the tongue. Thyroid tumors may develop from these rests. Cellular anlagen of thyroid tissue may also be displaced during development to appear in more distant parts, for example, in the ovary. Here it is usually associated with other elements, arising from similar, embryonically displaced but multipotent cells, or it may appear alone.

In later life, thyroid tissue may metastasize and implant itself in other situations, such as the lungs, bones, adrenals, etc. The stimulus to metastasize may be referred to the development of a frank carcinoma of the thyroid. A struma proliferans of Langhans' type may also break into the thyroid veins and be carried to distant organs. But such scattering of thyroid tissue in later life does not necessarily always imply the histologic characteristics of malignancy. Even a morphologically benign goitre may send out metastases which are in turn just as apparently benign as the parent tumor.

Ectopic thyroid tissue, wherever it be, is invested with the same potentialities as the thyroid gland in the neck. It may proliferate. It may grow and spread into adjacent tissue. It may become carcinomatous. Like the struma colli, with or without histological evidence of malignancy, it too may send out metastases.

In a case which I recently had the opportunity to study, in addition to a benign nodose struma colli, there were numerous goiterous nodules scattered in the omentum and on the intestinal serosa, and ectopic thyroid tissue was also found in an ovary. Metastases in later life from a struma colli, be it benign or malignant, have been described repeatedly in many organs, including those of the abdomen. But never, as far as I could find, have they been reported in the omentum. Embryonically displaced thyroid tissue has often been recorded in the ovaries, but never primarily within the peritoneal membrane. Primary tumors of the ovary are however particularly prone to peritoneal metastases. It is suggested therefore that the goiterous nodules in the omentum had come not directly from the struma colli, not as embryonic displacements of thyroid anlage, but as late secondary peritoneal metastases

from the benign, embryonically displaced ectopic thyroid tissue found in the ovary.

**CASE REPORT.—Clinical history.**—A colored female, thirty-eight years old, entered the Cook County Hospital with the complaint of a progressive dyspnoea of five months' duration, which had become suddenly worse in the last two weeks. She began gradually to pass large amounts of urine, and had to get up five or six times a night to urinate. Her vision began to fail rapidly. She felt tired and weak, lost about twenty-five pounds in weight, and in the last few weeks had vomited frequently.

Her past history included three spontaneous abortions, each late in pregnancy. Twelve years ago, at the Jane Terrell Hospital in Memphis, Tennessee, a left oöphorec-



FIG. 1.—Nodes of thyroid tissue in the greater omentum.

tomy had been performed. The ovary was large and cystic, but, grossly at least, showed nothing extraordinary. At the time, nothing unusual was noted in the omentum or anywhere else in the abdomen.

**Physical examination.**—On admission, she was drowsy, listless, disoriented except for brief, lucid intervals in which she could collect herself sufficiently to answer questions. Her pupils were irregular, unequal, fixed to light and accommodation. Conjunctivæ and finger nails were pale. Knee jerks were present.

The blood pressure was 198/128. The heart was markedly enlarged with its apex beat in the sixth interspace, and the left heart border in the anterior axillary line. The aortic second sound was roughened. Dullness, loud breath sounds and crackling râles were found over the right lung. Nothing at all was palpated in the abdomen.

The Kahn reaction of the blood was negative. There was a moderate albuminuria with a few granular casts. Blood chemistry returned a urea nitrogen of 151 milligrams/100 centimetres, and a creatinin of 10. Fundus examination showed a bilateral papilledema. Terminally a uremic "frost" appeared on the skin.



## ABDOMINAL METASTASIS OF THYROID TISSUE

*Clinical diagnosis was:* 1. Primary contracted kidneys with uræmia; 2. Hypertensive heart disease; 3. Syphilis.

*Autopsy (by Dr. R. H. Jaffé).—*The complexity of the pathological findings and the possibilities of varied interpretation, warrant a detailed description of this case.

*External description.—*The body was that of a poorly nourished colored female. In the midline of the abdomen, there was an ancient, healed, infra-umbilical, laparotomy scar, 13 centimetres long.

*Abdominal cavity.—*The lower border of the omentum was attached to the anterior abdominal wall at the site of the laparotomy scar, and to loops of lower ileum. Scattered over both surfaces of the greater omentum were numerous spherical nodules. They varied in size from the smallest, 1 by 5 millimetres, to the largest, 35 millimetres in diameter. They were firm, and, grossly, sharply distinct from the omental fat tissue.

On surfaces made by section there was a great variety of structures. Some of the nodules were light brown, finely granular and somewhat translucent, resembling thyroid tissue. The larger nodes showed a deep purple-red mottling, and opaque, light yellow-gray, irregular areas up to 1 by 4 millimetres in diameter. One of the nodes, 3 centimetres in diameter, had a firm, whitish capsule and a soft, medullary, light grayish-brown centre. Similar nodules were found in the mesentery along the small intestine. These were much smaller, 3 to 5 millimetres in diameter. Attached to the upper ileum was a single, larger, thyroid-like nodule 15 millimetres in diameter.

*Thyroid.—*Forty-four grams in weight. The right lobe measured 7.5 by 3.5 by 2 centimetres. In the lower pole was a sharply circumscribed, ovoid node 2.5 by 2 by 2 centimetres in diameter. It was mottled light brown-gray and deep purple-red, and had a distinct white fibrous capsule. The left lobe measured 5.5 by 2 by 1.9 centimetres. In its lower pole also was a spherical, sharply circumscribed,

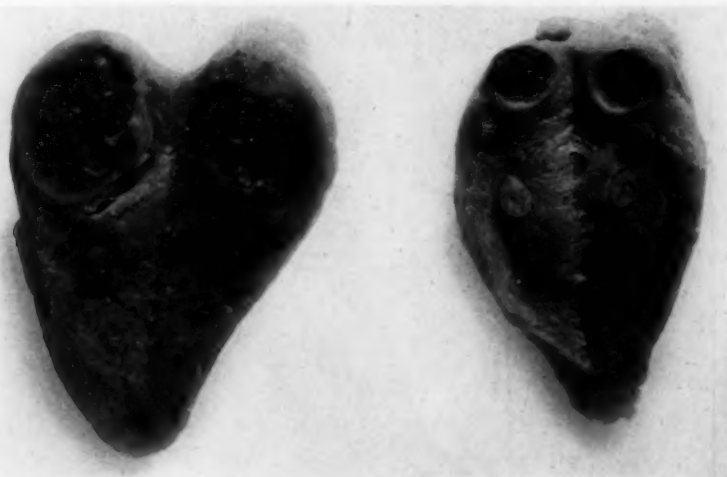


FIG. 2.—Left and right lobes of the thyroid gland, with multiple metastases.

9 millimetres, finely granular, purplish-brown nodule. In the isthmus of the thyroid was a similar nodule 8 millimetres in diameter. The remainder of the thyroid tissue was light pink-gray, finely granular, with single, firmer, lighter areas up to 5 millimetres in diameter. Grossly, no invasion of the thyroid veins by these nodules could be found.

*Ovaries.—*The left ovary was missing. The right ovary and Fallopian tube were imbedded in fibrous adhesions. The ovary was 4 by 3 by 3 centimetres in diameter. It was firm, but contained several cysts from 1 to 16 millimetres in diameter. There were also more solid, light grayish-brown, finely granular, somewhat translucent areas up to 5 or 6 millimetres in diameter. The remainder of the ovary was composed of firm, grayish-white tissue.

*Heart.* 418 grams. Left ventricle 20 millimetres thick, right ventricle 4 millimetres. The myocardium was pale, grayish-brown, streaked with yellow.

*Aorta.* Focal areas of irregular, intimal wrinkling in the supravalvular portion.

*Lungs.* The left lung had three lobes. Surfaces made by section were purplish-gray, and very moist with frothy fluid. The right lung showed, in addition, in its lower lobe, numerous gray, granular areas of consolidation.

*Stomach.* The mucosa was deeply injected, and covered by much, thick, yellowish-gray mucus. *Spleen.* 170 grams. Firm, purplish-red. *Liver.* 1700 grams. Firm, purplish-brown mottled with yellowish-brown. Markings obscure. *Pancreas.* 90 grams. Light yellow-gray. *Adrenals.* 19 grams together. Cortex light gray.

*Kidneys.* 300 grams together. Firm. The capsule stripped with difficulty leaving a finely granular surface. The granules were light gray, separated by dark purple lines. The cortex was 5 millimetres wide, mottled purple-gray and light gray. In the medulla of the right kidney there was a cyst 3 centimetres in diameter. The pelvic mucosa was pale gray, with circumscribed deep purple patches.

*Brain.* 1400 grams. The convolutions were slightly flattened, the leptomeningi thin. The brain substance was soft and wet. The internal carotid arteries were stiff-walled with numerous hyalin plaques.

*Hypophysis.* In the roof of the sella turcica, there was a circular opening of the dura mater, 10 millimetres in diameter. The hypophysis was atrophied, its superior aspect sunken, so that the gland formed a saucer-like disc in the floor of the sella.

# PHILLIP F. SHAPIRO

**MICROSCOPIC EXAMINATION.** 1. *Thyroid.*—All parts of the thyroid gland were sectioned.  
a. *Right lobe:* The large node was separated from the remaining parts of the thyroid by a distinct capsule of fibrillar connective tissue. The capsule was of varying thickness, but nowhere was it interrupted. The node was composed of follicles of varying size which were separated into irregular groups by a stroma of dense, hyalin connective tissue. This fibrous tissue was most abundant near the



FIG. 3.—Thyroid tissue and cysts in the right ovary.

central portions. In each group of follicles one type usually predominated. There were groups with very small follicles with narrow lumina which were either empty, or contained a pale stained material. The lining of these was regular, cuboidal, and the cells contained round nuclei with a fine net of chromatin granules.

As the follicles increased in size, the lining became lower, and the content showed a greater affinity for the acid stain. The largest follicles sometimes showed a central basophilic and a peripheral oxyphilic colloid. There were follicles with recent hemorrhages in the lumen. Others showed large mononuclear cells filled by blood pigment or lipid droplets. Some of the follicles contained small, basophilic droplets with lipid granules suspended in a light stained basement substance (spheroids).

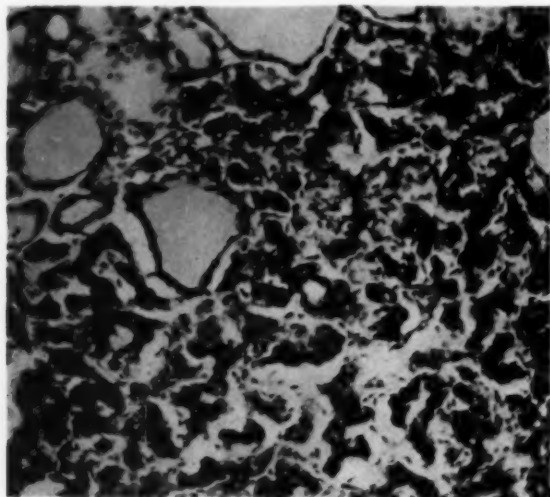


FIG. 4.—Left lobe of thyroid gland. Nodule with trabeculae resembling Langhans' type of proliferating struma. Hematoxylin and eosin. Leitz apochromat 4 millimetres, periplanar 4.

In the stroma there were many recent hemorrhages, and remnants of such in the form of brown hemosiderin deposits. In a few places the stroma contained small granules of calcium. A large artery entering the node had a much thickened intima with an extreme narrowing of the lumen. Outside the node, the thyroid was uniformly composed of medium-sized, colloid-filled follicles which were arranged in regular lobules. These were separated by a slightly increased amount of stroma. In the upper pole was another small, encapsulated, 5 millimetre nodule. It was composed of small, medium-sized, and large follicles filled by colloid, and lined by a regular epithelium. The isthmus was of similar structure.

b. *Left lobe:* The large node resembled that described in the right lobe. In addition to it, there were several smaller nodules. They were made up of small and medium-sized follicles. But one of these nodules contained, in addition to the follicles, a small area which was composed only of anastomosing cords of regularly shaped, small cuboidal cells.

In no place in the entire gland, not even in the nodule containing the anastomosing cords of cuboidal cells, was there any invasion of the veins by thyroid tissue. The lumen of the veins was wide open and empty. In no place in the thyroid, was there any infiltration of the capsule.

2. *Nodules in greater omentum.*—Several nodules were sectioned. All answered essentially to the same histologic description. Each nodule was separated from the mesenteric fat tissue by a thin and continuous capsule of connective tissue. In places the nodules extended to the free surface of the omentum. They are composed of oval or branched, elongated spaces separated by thin strands of fibrillar connective tissue. Some of these strands were thick, hyaline, and contained much dark brown pigment engulfed by cells. The spaces varied from twenty-five to several hundred microns in

## ABDOMINAL METASTASIS OF THYROID TISSUE

diameter. Their content was pale, homogeneous and oxyphilic, similar to that of the thyroid. At times it was hemorrhagic, or showed the remnants of hemorrhages in the form of fatty acid needles, and free vacuolated and pigmented mononuclear cells. The majority of the spaces were lined by very flat or by low cuboidal epithelium. There were, however, places in which the epithelium was high cylindrical, slender, with basal round nuclei. This epithelium sometimes lined only part of a follicular space, while the rest was lined by flat epithelium. The portions with the high epithelium often pro-

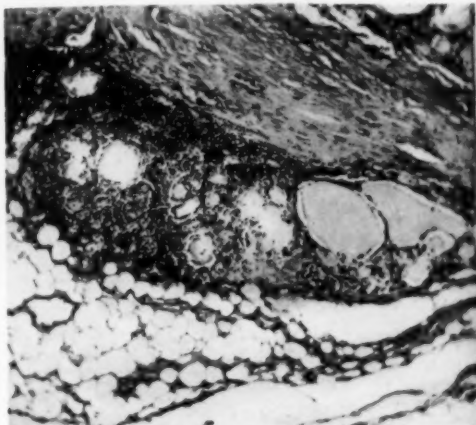


FIG. 5.—Thyroid nodule in omentum showing extension of thyroid tissue into the omental fat tissue. Hemotoxylin and eosin. Leitz apochromat 16 millimetres, periplanar 4.

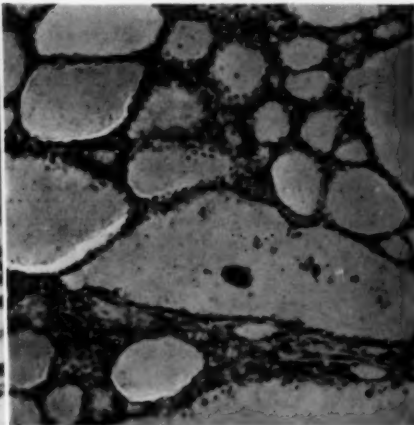


FIG. 6.—Thyroid nodule in omentum. Sudan III stain to show lipid droplets within the epithelial cells, and spheroids, lipid drop clusters and foam cells within the colloid. Leitz apochromat 4 millimetres, periplanar 4.

truded as small, solid, proliferating masses into the lumen. Adjacent to these protrusions there were many, very small, young follicles. In the periphery of the nodules there were numerous, small, circumscribed accumulations of lymphocytes. In one nodule, though it possessed a distinct capsule, small groups of follicle-like spaces were found, *outside the capsule*, extending between the adjacent fat cells which appeared slightly compressed. This apparently represented the mode of extension of the nodules. In these places, the interstitial accumulations of lymphocytes were more marked. In the

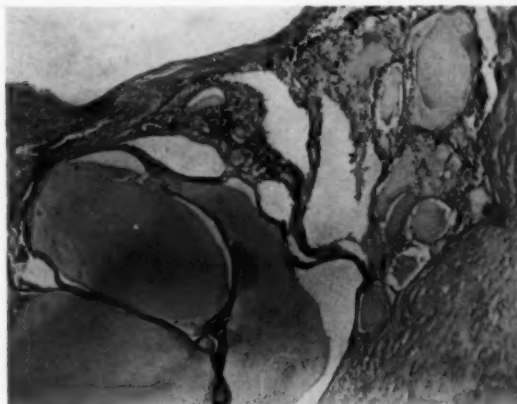


FIG. 7.—Thyroid tissue in right ovary showing extension to the surface. Hemotoxylin and eosin. Leitz apochromat 16 millimetres, periplanar 4.

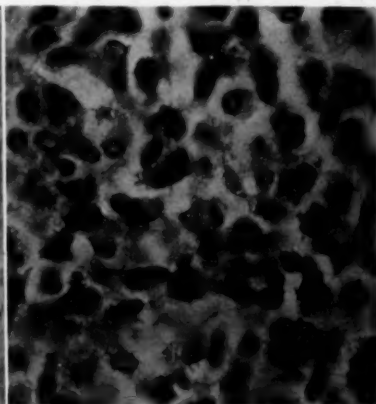


FIG. 8.—Basophil cells in posterior lobe of hypophysis. These cells were altogether different from the basophil cells of the anterior lobe. Giemsa stain. Leitz apochromat oil immersion 2 millimetres, periplanar 4.

fat stain, the epithelial cells were found to contain a moderate number of small lipid droplets. In the light stained, colloid-like content of the follicles there was a varying number of small spheroids with fine lipid granules. Many of the follicles contained extra- and intra-cellular clusters of larger, bright orange-yellow fat droplets. In the stroma also, there were a few branched cells with fine lipid granules.

Some of the nodules were submitted to Dr. R. W. Webster, coroner's chemist, for examination. They yielded iodine in a quantity equivalent to 8.69 milligrams per 100 grams of dried tumor.

3. *Right ovary.*—Sections were taken from all parts of the ovary. There was only a small amount of ovarian tissue left. It was restricted to the hilus and to a narrow marginal zone adjacent to the hilus. It showed the characteristic stroma with numerous corpora albuginea, thick-walled arteries, and a few small, follicular cysts.

The bulk of the ovary was composed of thick, wavy, hyalin masses which in places were loosened, and contained various-shaped and various-sized cavities which appeared empty. These masses surrounded groups of other round or oval spaces from 50 to 200 microns in diameter, filled by a homogeneous, colloid-like, pink-stained material. The spaces were lined by a very flat and indistinct epithelium, in which no goblet cells were found. Some of these spaces contained foamy cells, and cells filled by light brown pigment. The larger spaces were lined by flat epithelium, the smaller by low cuboidal epithelium resembling that of the thyroid. In places these follicle-like spaces extended to the surface of the gland.

With Kraus' modification of Unna's polychrome-methylene blue, acid fuchsin-tannic acid stain,<sup>1</sup> the follicles described in the thyroid, in the omental nodules, and in the ovary were all revealed to be filled by the same blue and bluish-violet homogeneous colloid. By this differential stain the colloid of the thyroid, of the omentum, and of the ovary were found to be *tinctorially identical*.

4. *Hypophysis.*—The anterior lobe showed no essential microscopic changes, except for a slight increase in the interstitial tissue. Adjacent to the zona intermedia, and occupying the inferior half of the posterior lobe, there was a well-defined area composed of cords of polyhedral or cylindrical cells. These cells resembled none of the anterior lobe types. They had a finely granular, purple-pink cytoplasm, in contrast to the deep purple cytoplasm (Giemsa stain) of the anterior lobe basophils. Their nucleus was eccentric, round, with many fine chromatin granules. Posteriorly these cords radiated into the glia, became separated from one another, and gradually disappeared.\*

5. *Lungs.*—Microscopically, no evidence of thyroid metastases could be found in the lungs.

6. *Kidneys.*—There was a severe arteriosclerosis, with many hyalinized glomeruli. Single glomeruli showed distinct capillary dilatation, others an actual fibrinoid necrosis which extended into the afferent and intra-lobular arterioles.

The adrenal arterioles showed also a marked thickening of their intima. In the liver and spleen there was diffuse capillary dilatation. The bone marrow was very cellular with active granulopoiesis and erythropoiesis. The aorta offered the typical histologic picture of a syphilitic aortitis.

*Anatomical Diagnosis.*—1. Malignant nephrosclerosis with arteriolo-necrosis. 2. Eccentric hypertrophy of the heart and fatty degeneration of the myocardium. 3. Syphilitic aortitis and atheromatosis. 4. Nodose goitre. 5. *Struma ovarii* of the right ovary, with multiple metastases to the greater omentum, mesentery and visceral peritoneum. 6. Confluent bronchopneumonia of the right lower pulmonary lobe. 7. Edema of the brain. 8. Absent left ovary, and ancient laparotomy scar.

**DISCUSSION.**—The essential clinical picture and the cause of death was malignant nephrosclerosis, ending in uræmia. The thyroid nodules scattered through the abdomen were benign incidental findings. By their size and encapsulation it was apparent that the nodules had been in the abdomen for some time. They might have remained there for many years more without causing any disturbance, had not the renal involvement prematurely terminated the case. The omental nodules had nothing to do with her illness or death.

That these benign nodules were really thyroid tissue, was readily demonstrable. Grossly they looked like goiterous nodules. Histologically they were identical with the nodose goitre in the neck. They answered to the classical description of a simple, macro- and micro-follicular, nodose colloid goitre. They showed the same degenerative and hæmorrhagic changes which were found in the struma colli. They showed the same papillary and proliferative epithelial changes which are typical for any growing nodose goitre.

The colloid they contained was *tinctorially identical*, by Kraus' stain, with that of the thyroid in the neck. Fat stain revealed in this colloid, the lipid clusters and foam cells and spheroids which are characteristic of thyroid tissue. These lipid droplets are the products of secretory activity of thyroid epithelium (Jaffé<sup>6</sup>). Their presence in the omental nodules ascribed to this tissue the same thyroid function character. Finally, iodine was demonstrated chemically in ample quantity, from sample nodules. The

\* These cells in the posterior lobe were only an incidental finding, but are described in detail because they correspond to structures which Loeffler,<sup>2</sup> and Maurer, Lewis and Lee<sup>3,4,5</sup> have recently emphasized. They are not inwandering cells from the anterior lobe, but are special differentiations from the posterior wall of Rathke's pouch. If man has a *pars intermedia*, these cell groups represent the closest approximation to it.



## ABDOMINAL METASTASIS OF THYROID TISSUE

presence of this iodine indicated also the possibility of thyroid function. From all these lines of evidence it was clear that the omental nodules were really thyroid tissue.

The question then arose as to how these thyroid nodules had gotten into the omentum. They might have come from a frankly anaplastic thyroid carcinoma in the neck. Histologically, the omental nodules were altogether benign. But thyroid carcinoma metastases, though usually malignant, have a tendency to assume more mature character, and appear benign. Even these apparently innocent secondary nodules in the omentum might still then have come from a malignant primary tumor in the neck. But histologic examination of sections from every part of the nodose struma colli failed to reveal the slightest evidence of malignancy. There was not the smallest focus in it, for definitely malignant spread.

With carcinoma excluded, the omental nodules might still have come from a struma proliferans of Langhans' type. Langhans described a type of metastasizing goitre which could be distinguished both from carcinoma and from benign glands.<sup>7</sup> They are composed of anastomosing cords of cuboidal cells. They tend to break into veins, and thus metastasize by way of the blood-stream, to set up similar nodules in distant organs.<sup>8</sup> They offer a possible source for thyroid metastases other than the ordinary carcinoma.

Only in one of the sections from the left lobe of the thyroid was there found a very small area of these "anastomosing cords of cuboidal cells." That these cords were responsible for sending out the thyroid metastases was unlikely. They were apparently quite a recent development, unquestionably younger than the nodes in the omentum and ovary. They did not break into the thyroid veins, and nowhere in the omental nodules was there found any reproduction of the solid, cellular cords.

With a struma proliferans also excluded, it was still possible for a simple, nodose struma colli to have sent out the benign metastatic nodules. Cohnheim, in 1876, first described a case of this type.<sup>9</sup> Great controversy has raged since then about the true nature of these so-called, "Benign Metastasizing Adenomas" (see Simpson,<sup>10</sup> Ewing,<sup>11</sup> Alessandri,<sup>12</sup> Pool<sup>13</sup>). Many cases have since been reported, but Wegelin<sup>14</sup> accepted only fourteen from the literature as being histologically adequately proved, benign metastases from benign goitres.

Histologically these goitres look benign. The sections from the thyroid gland in these cases would be altogether indistinguishable from the hundreds of nodose goitres examined routinely and dismissed as benign. Yet they metastasize. Graham<sup>15</sup> therefore indicated that in these cases, benign cellular structure could not be used as a reliable criterion. A nodose goitre might appear quite benign. But if it showed invasion of the capsule, or particularly the thyroid veins, it could—though it necessarily need not—give rise to metastases.<sup>16</sup> Even in the first cases described, Cohnheim had observed this. But no such invasion could be found in the case here reported. Nowhere, throughout the benign gland, were there any goitre nodules break-



ing through the capsule, or into the thyroid veins. There were no histologic findings upon which to accept, readily, the struma colli as even a benign metastasizing adenoma. It was a simple, benign goitre with no indication at all of a tendency to metastasize.

Be they derived from carcinomas, or from proliferating strumas, or from benign nodose goitres, thyroid metastases are known to elect certain characteristic locations. Usually they appear in the lungs, and in various bones<sup>17, 18, 19, 20</sup>. They have also been found in the heart, kidneys, liver, skin,<sup>21</sup> in the chorioid plexus, in the adrenal, and in the chorioid coat of the eye.<sup>22</sup> But never have any been described so far, in the omentum or on the peritoneal surface of abdominal viscera. That the altogether benign struma colli should have metastasized at all, was unlikely. That having metastasized, it should avoid its elected positions in the lungs, bones, heart, liver, etc., only to appear exclusively in a quite unprecedented location, the omentum, was even more unlikely. There was no evidence at all sufficient to support the omental thyroid nodules as adult metastases from any struma colli. The gland in the neck could not then, readily be invoked as their primary source.

Ectopic thyroid tissue was also found in the ovary. On surfaces made by section, there were areas in the ovary between its larger cysts which, even grossly, resembled thyroid tissue. Microscopically, these areas repeated the structure of any nodose colloid goitre, showing even similar degenerative changes. Krous' stain here too revealed the identity of the colloid in the ovarian thyroid follicles with the colloid in the struma colli, and that in the omental nodules. An iodine determination was not made because the small amount of ovarian material available was used up in the histologic study. But morphologically and tinctorially the tissue in the ovary was undeniably thyroid.

Thyroid tissue in the ovary has been described many times.<sup>23</sup> There may be only a little of it buried within the ovary. It may replace most of the ovarian substance. It may even do so entirely, so that in place of an ovary, there is found only a mass of thyroid tissue.<sup>24</sup> This may involve only one ovary or both.<sup>25</sup> Gottschalk<sup>26</sup> first described this tissue within the ovaries, but mistook it for a folliculoma. Kretschmar<sup>27</sup> recognized its identity with thyroid tissue, but assumed that it arose as a benign metastasizing adenoma of the neck.

Here, too, it was at once contested that goitres are not known to metastasize to the ovaries. The struma colli in these cases might not show the slightest invasive tendency. If metastatic nodules of a carcinoma or a struma proliferans or of a benign invading struma are not found in the ovaries, it is quite unlikely that the ovary should alter its warranted disposition to accept these nodules from a perfectly benign, non-invading goitre. Benign thyroid tissue might wander elsewhere, just as do the malignant thyroid tumors, but in the ovary its presence could also not readily be accounted for on a metastatic basis, from the neck.

Pick<sup>28</sup> then observed that often, along with the thyroid tissue, there was

## ABDOMINAL METASTASIS OF THYROID TISSUE

also found in these ovaries, a variety of other structures such as bone, teeth, hair, cartilage, sebaceous material, intestinal epithelium and nervous tissue. Calcium, cartilage and even bone may appear in degenerating thyroid tissue. But degenerative changes can certainly not account for the presence of the hair, teeth, nervous tissue, etc. in these tumors. The complexity and variability in association of these structures suggested an embryogenic disturbance, an embryonic displacement into the ovary of multipotent cells which might in later life proliferate in the direction of forming thyroid tissue. Pick therefore conceived the struma ovarii to be not a metastasizing adenoma, but part or the whole of a teratoma.

Teratomas occur frequently in the ovaries, and thyroid tissue is often encountered in them as incidental parts of their variegated structure. In twenty-one dermoids which Pick examined, he found thyroid tissue in six. In one hundred cases of ovarian dermoid, Koucky found thyroid tissue in 19 per cent. Teratomas are totipotent, but any structure may outgrow the others. The thyroid tissue may predominate. Morgen<sup>30</sup> suggested that if a patient has a dermoid cyst of the ovary containing thyroid tissue, it is perhaps the same endocrine disturbance which usually leads to the development of a nodose struma colli, which may also call forth in her a goiterous development of the dermoid, and produce the struma ovarii.

The thyroid tissue may predominate even to the exclusion of the other elements. In most cases, even if the ovary shows grossly only thyroid tissue, microscopic examination reveals the presence also of various teratoid elements.<sup>31</sup> Occasionally, however, even careful examination by serial section fails to reveal anything but thyroid tissue in the ovary. In my case, thyroid was the sole constituent of the tumor. No other dermoid elements could be found with it.\* Manasse<sup>34</sup> reported a similar case. He too emphasized that the thyroid element of a teratoid tumor, may, by elective growth, drop all of its companion teratoid structures and appear alone.

Pseudo-mucinous cystadenomas are similarly developed by preponderant growth of the intestinal epithelium elements of an ovarian teratoma, as the struma ovarii develops from its thyroid elements. Struma ovarii and pseudo-mucinous cystadenomas are indeed not only similar in origin, but are rather similar in appearance. Bauer<sup>35</sup> in fact, while admitting that the so-called "struma ovarii" originated as one-sided developments of teratomas, contested that they were not thyroid at all, but only modified pseudo-mucinous cysts. The dermoid structures often found associated, he dismissed as purely accidental companions. Most investigators have firmly refuted this suggestion. Even Kaufmann, in whose laboratory Bauer worked, denied it.

Struma ovarii is really an embryogenic, ectopic thyroid tumor. Morphologically, it is not merely similar to, but is identical with thyroid tissue. The

\* Kovacs offers as a more correct term than "struma ovarii," that of "teratoma strumoides ovarii." Since most of these growths are not trigeriminal, to be absolutely correct, we should speak of a "teratoid strumoid tumor of the ovary." For brevity and because of established usage, the term "struma ovarii" will be retained in this paper.

contents of its follicles do not give the staining reactions or the chemical reactions for pseudo-mucin, at all (Kafka,<sup>36</sup>). Chemically this content is, however, identical with the colloid of the thyroid gland. Iodine has been demonstrated from time to time within it. Most of these strumæ do not function, any more than do the muscle or nerve or intestinal or tooth structures which may accompany them in the teratoma. But even a vicarious thyroid function has been observed clinically in the cases of struma ovarii reported (Morgen,<sup>30</sup> Kovacs,<sup>37</sup> Moench<sup>38, 39, 40</sup>).\*

Like thyroid tissue in the neck, struma ovarii may become malignant. Moench reported one case with adeno-carcinomatous transformation in the centre of an otherwise benign ovarian thyroid. Frankl reported another, but in neither had metastases occurred. Without becoming definitely malignant, struma ovarii may begin to proliferate and break through the capsule of the ovary. Polano<sup>41</sup> described such a case, but the struma had not extended beyond the surface of the ovary.

Just like the pseudo-mucinous cystadenoma, a strumoid tumor may extend to the surface of the ovaries and extend beyond them. It may creep along the peritoneal surfaces, and implant itself everywhere in the peritoneal cavity. Morgen observed such implantation metastases in the course of a double oöphorectomy for a case of bilateral ovarian struma. Both ovaries and a biopsy from one of the metastatic nodules revealed a papillary struma nodosa. He concluded that it is the papillary form of struma which is most likely to spread from the ovary by implantation. But even the non-papillary type may metastasize.

Werth<sup>42</sup> reported a case of simple, non-papillary, struma ovarii in which, scattered over the peritoneum, there were numerous small nodules of the same thyroid tissue. These implantation metastases were restricted to the pelvis minor. The case here reported conforms to the same type of simple struma nodosa colloides, but its metastases had gone even further. They had spread chiefly up into the greater omentum. Adhesions of the omentum to the old operative site had perhaps directed this spread. The implanted nodules continued to proliferate. They extended freely along the omental fat tissue and finally into the intestinal serosa. They multiplied until the omentum was thickly strewn with them.

#### SUMMARY AND CONCLUSIONS

A case is reported in which as purely incidental autopsy findings, thyroid nodules were observed scattered over the omentum and the peritoneal surface of the intestines. Thyroid tissue was also found in the ovary. The patient had a nodose goitre, but the omental nodules had apparently not arisen from a

\* Manasse suggested that when there is a question of thyroid function of a struma ovarii, the tissue be used for a Gudernatsch acceleration of metamorphosis test. In his own case the possibility occurred to him only after the tissues were fixed. This was likewise my experience. It is hoped that some future case of struma ovarii will be so tested.

benign metastasizing adenoma. Neither had the thyroid tissue in the ovary been so derived.

The struma ovarii had arisen from an embryonically displaced thyroid anlage. It had developed by selective overgrowth of the thyroid elements of a teratoid tumor of the ovary in much the same way that a pseudo-mucinous cystadenoma develops from the intestinal epithelium anlage of a teratoma ovarii. Like the latter tumor, it had been able to send extensive implantation metastases into the omentum and peritoneal linings. Like the pseudo-myxoma peritonei produced by a cystadenoma, the struma ovarii had yielded in this case a strumatositis peritonei.

#### REFERENCES

- <sup>1</sup> Kraus, E. J.: Das Kolloid der Schilddruese und Hypophyse des Menschen. Virchow's Archiv., vol. ccxviii, p. 107, 1914.
- <sup>2</sup> Loeffler, E.: Ueber ortsfromde Zellen und Geschwuelste im Hinterlappen und im Stiel der Hypophyse. Virchow's Archiv., vol. cclxxiv, p. 326, 1929.
- <sup>3</sup> Maurer, S. and Lewis, D.: The Structure and Differentiation of the Specific Cellular Elements of the Pars Intermedia of the Domestic Pig. Jour. Exper. Med., vol. xxxvi, p. 141, 1922.
- <sup>4</sup> Lewis, D.: A Contribution to the Subject of Tumors of the Hypophysis. J. A. M. A., vol. lv, p. 1007, 1910.
- <sup>5</sup> Lewis, D. and Lee, F. C.: On the Glandular Elements in the Posterior Lobe of the Human Hypophysis. Bull. Johns Hopkins Hosp., vol. xli, p. 241, 1927.
- <sup>6</sup> Jaffe, R. H.: Histologic Studies on the Fat Content of the Normal Human Thyroid. Arch. of Path. and Lab. Med., vol. iii, p. 955, 1927.
- <sup>7</sup> Langhans, Th.: Weitere Mitteilungen ueber die epitheliale Struma. Virchow's Archiv., vol. ccvi, p. 419, 1911.
- <sup>8</sup> Kaufmann, E.: Pathology. P. Blakiston's Son & Co., Philadelphia, 1929.
- <sup>9</sup> Cohnheim, J.: Einfacher Gallertkropf mit Metastasen. Virchow's Archiv., vol. lxxviii, p. 547, 1876.
- <sup>10</sup> Simpson, W. M.: Three Cases of Thyroid Metastases to Bones, with a Discussion of the Existence of the So-called "Benign Metastasizing Adenoma." Surg., Gynec. & Obst., vol. xlii, p. 489, 1926.
- <sup>11</sup> Ewing, J.: Neoplastic Diseases. W. B. Saunders Co., Philadelphia, 1928.
- <sup>12</sup> Alessandri, R.: Thyroid Bone Tumors without Primary Lesion of the Thyroid Gland. Surg., Gynec. & Obst., vol. xlv, p. 35, 1927.
- <sup>13</sup> Pool, E. H.: Malignant Growths of the Thyroid. ANNALS OF SURGERY, vol. lxxxv, p. 120, 1927.
- <sup>14</sup> Wegelin, C.: Druesen mit innere Sekretion. Handbuch der speziellen pathol. Anat. u. Hist. Henke u. Lubarsch., Julius Springer, Berlin, 1926.
- <sup>15</sup> Graham, A.: Malignant Epithelial Tumors of the Thyroid, with Special Reference to Invasion of Blood Vessels. Surg., Gynec. & Obst., vol. xxix, p. 781, 1924.
- <sup>16</sup> Brinkmann, E.: Metastasierende parenchymatoese Struma nodosa in ihrer Beziehung zur Unfallbegutachtung. Klin. Wchnschr., vol. vi, p. 1903, 1927.
- <sup>17</sup> Ginsburg, S.: Bone Metastases. Am. J. Roentgenol., vol. xviii, p. 203, 1927.
- <sup>18</sup> Ferrero, V. & Sacerdoti, G.: Thyroid Tumors in Bones. Archivio Italiano di Chirurgia, vol. xiv, p. 274, 1925; ab. J. A. M. A., vol. lxxxvi, p. 381, 1926.
- <sup>19</sup> Middeldorpf, K.: Zur Kenntniss der Knochenmetastasen die Schilddruesentumoren. Arch. f. klin. Chir., vol. xlvi, p. 502, 1894.
- <sup>20</sup> Dreesmann, C.: Ueber struma metastase. Med. Klin, vol. e, 1925.

- <sup>21</sup> Falta, W.: The Ductless Glandular Diseases. P. Blakiston's Son & Co., Philadelphia, 1915.
- <sup>22</sup> Cords, R. u. Eigel, W.: Struma-metastasen im Auge. Arch. f. Ophth., vol. cxviii, p. 478, 1927.
- <sup>23</sup> Koucky, J. D.: Ovarian Dermoids. ANNALS OF SURGERY, vol. lxxxi, p. 821, 1925.
- <sup>24</sup> Riebel, F. A. and J. A.: Teratoma of Ovary Containing Thyroid Tissue. Ohio State M. J., vol. xxiii, p. 304, 1927.
- <sup>25</sup> Bell, R.: On the Appearance of Thyroid-like Structures in Ovarian Cysts. Jour. of Ob. Brit. Empire, vol. viii, p. 92, 1905.
- <sup>26</sup> Halban, J. und Seitz, L.: Biologie und Pathologie des Weibes. Urban & Schwarzenberg, Berlin, 1926.
- <sup>27</sup> Kretschmar, J.: Eine seltene, kleincystische maligne Eierstockgeschwulst. Verhand. d. deutsch. Gynaek. Ges., vol. cccclix, p. 9, 1901.
- <sup>28</sup> Pick, L.: Ueber Struma thyreoidea aberrata ovarii. Dtsch. Medizinalzeitg., vol. xxxv, p. 412, 1902.
- <sup>29</sup> Frankel, J. M. & Lederer, M.: Struma ovarii (3 cases). Am. J. Obst. & Gynec., vol. xvi, p. 367, 1928.
- <sup>30</sup> Morgen, M.: Ueber-Struma thyreoidea ovarii papillares und die Frage der Funktion der ovariellen Schilddruesentumoren. Virchow's Archiv., vol. ccxlix, p. 217, 1924.
- <sup>31</sup> Walthard, J.: Ueber Struma colloides im Ovarium. Zeitscher. f. Gynack., vol. ix, p. 50, 1903.
- <sup>32</sup> Saxer, F.: Ein Beitrag zur Kenntniss der Dermoide und Teratome. Beitr. z. path. Anat. u. z. alg. Path., vol. xxxi, p. 452, 1902.
- <sup>33</sup> Meyer, R.: Ueber embryonische Gewebsanomalie und ihre pathologische Bedeutung. Ergeb. d. path. Anat. Lubarsch Ostertag, Jahrgang 15, Abteilung 1, 1911.
- <sup>34</sup> Manasse, T.: Ueber Struma ovarii. Ztschr. f. Geburtsh. u. Gynack., vol. lxxxix, p. 638, 1926.
- <sup>35</sup> Bauer, E.: Ueber die sogenannte Struma ovarii. Zeitschr. f. Geburtsh. u. Gynack., lxxv, p. 617, 1914.
- <sup>36</sup> Kafka, V.: Zur Kenntniss der Struma ovarii. Arch. f. Gynack., vol. cxiv, p. 587, 1921.
- <sup>37</sup> Kovacs, F.: Ueber die Schilddruesengeschwulst des Ovariums. Arch. f. Gynack., vol. cxcx, p. 766, 1924.
- <sup>38</sup> Moench, G. L.: Thyroid Tissue Tumors of the Ovary. Surg., Gynec. & Obst., vol. xlix, p. 150, 1929.
- <sup>39</sup> Koerner, J.: Zur Frage der Struma ovarica. Monatschr. f. Geburtsh. u. Gynack., vol. lxviii, p. 264, 1925.
- <sup>40</sup> Haggag, H.: Schilddruesenstruma und Pseudomucincystom. Virchow's Archiv., vol. cclxiv, p. 686, 1927.
- <sup>41</sup> Polano, O.: Pseudo-endothelioma des Eierstockes. Zeitschr. f. Geburtsh. u. Gynack., vol. li, p. 29, 1904.
- <sup>42</sup> Werth, G.: Beitrag zur Pathologie und Klinik der Struma ovarii. Zentralbl. f. Gynack., vol. lii, p. 294, 1928.



## TUMORS OF THE WALL OF THE THORAX

BY M. M. ZINNINGER, M.D.

OF PEIPING, CHINA

FROM THE DEPARTMENT OF SURGERY OF PEIPING UNION MEDICAL COLLEGE

TUMORS arising from the thoracic wall are sufficiently uncommon so that the experience of any one individual with them is rather limited. For this reason it seems advisable to report cases of such tumors in order to place them on record, and thus make available the experience of many. In 1921, Hedblom<sup>1</sup> collected two hundred thirteen cases of tumor of the bony chest wall. These included the series of Parham<sup>2</sup> (1898) and of Lund<sup>3</sup> (1913), thirty-five cases from the literature and forty-eight cases from the records of the Mayo Clinic, most of which were Hedblom's own cases. In 1925, Heuer<sup>4</sup> collected twenty-two additional cases to which he added five of his own, making a grand total of two hundred thirty-eight cases reported.\* Since 1925, I have found reports of twenty more cases (fifteen in a report by Harrington<sup>5</sup>) to which I wish to add seven cases from the records of the Peiping Union Medical College Hospital, and one case from another Peiping Hospital. In addition, five cases of superficial tumor are reported, and three cases of intrathoracic tumor presenting through the thoracic wall.

In the reports in the literature, the origin of the tumors is not always clear, intrathoracic tumors and tumors of the ribs and vertebræ all being listed together. Another confusing feature in most reports is the inclusion in the groups of tumors of cases of cold abscess, osteitis, chondritis, and abnormally prominent rib.

The incidence, etiology, diagnosis and treatment of these tumors have been so well covered by Hedblom, Heuer, Harrington and others that there is no necessity to detail them again. A few points, however, are worthy of further mention. In the first place, the pathology of many of these tumors is not clear. The majority are sarcomas of one variety or another, chiefly chondrosarcomas, but many are unusual in nature, and have not been clearly classified. There is even greater confusion in the classification of the intrathoracic tumors and tumors arising in the lung. The relation of trauma to the development of these tumors is likewise not clear. Often the tumors seem to have occurred just at the site of a previous trauma, but in many other instances it is impossible to obtain a history of trauma. The diagnosis of the type of tumor before operation has often been quite difficult, as also the determination of the point of origin. Rapid growth and pain favor a diagnosis of malignancy.

Early and radical operative removal is clearly the treatment of choice, as it is generally conceded that partial removal followed by radiation is of

---

\* Heuer excluded two of Lund's cases because they were incompletely recorded.

very little value; but it must also be remembered that tumors which histologically appear benign may recur after an apparently complete excision. There is a marked difference of opinion among surgeons as to the advisability of using pressure anaesthesia during the operation—some using it routinely while others report no untoward effects from opening the pleura wide without pressure anaesthesia.

The cases here reported from the Peiping Union Medical College Hospital have been divided into several groups: (A) tumors arising from the deep structures of the thoracic wall and partly intrathoracic; (B) tumors arising from the more superficial structures of the thoracic wall, but on clinical examination found to be apparently fixed to the deep structures; (C) tumors arising within the thorax and presenting through the thoracic wall. Subcutaneous fibromas and lipomas have not been included, nor have several small chondromas of the ribs which caused no symptoms, and which were observed during routine physical examination.

*Group A*

Date	Age	Sex	Trauma	Right or Left	Diagnosis	Treatment	Result
1924	29	M	o	R	Osteo-sarcoma (fibro-sarcoma) of rib	None	Not known
1925	38	M	o	R	Tumor of D 7 vertebra	None	Not known
1926	18	M	o	R	Osteo-sarcoma of rib	None	Not known
1928	26	F	o	L	Osteoma of rib	Resection	Well 1 year
1929	51	M	o	L	Sarcoma of ribs	None	No change
1929 1930	23	M	±	R	Fibro-sarcoma thoracic wall	Resection	Recurrence 4 months. Resection
1928	47	M	o	St.	Tumor of sternum? Aneurysm	Application of radium	No change
1928*	31	M	o	R	Chondro-sarcoma rib	Resection	Died

\* Not operated on at P.U.M.C. Surgical specimen sent for examination.

There are eight cases in group A, one being the surgical specimen from another hospital. Three of the eight cases were subjected to radical resection. Of these three, one patient died, one developed a recurrence which

*Group B*

Date	Age	Sex	Trauma	Right or Left	Diagnosis	Treatment	Result
1921	48	M	o	R	Round-cell sarcoma	Excision	Not known
1923	22	M	x	R	Sarcoma? Endothelioma?	Excision	Not known
1924	31	M	o	R	Mixed-cell sarcoma	X-ray treatment	Not known
1928	33	M	o	L	Fibro-sarcoma	Excision	Well 2 yrs.
1923	35	M	o	R	Sarcoma	None	Not known

## TUMORS OF WALL OF THORAX

was subsequently removed and the other has remained well for more than a year.

In group B there are five cases, three of which were operated upon, all apparently being cured.

### *Group C*

Date	Age	Sex	Trauma	Right or Left	Diagnosis	Treatment	Result
1928	12	F	o		Mesothelioma	None	Died
1924	45	M	o		Mesothelioma	None	Died
1922	50	F	o		Carcinoma	None	Not known

In group C there are three cases, none of which was operated upon. Autopsy was performed in two instances.

A single case, possibly lymphosarcoma, is briefly mentioned.

The accompanying tables show the types of tumor, treatment, and results.

## CASE REPORTS

### *Group A*

CASE I.—A Chinese male, twenty-nine years of age, was admitted to the hospital December 4, 1924, complaining of a hard mass in the wall of the chest on the right side. The tumor was first noticed about nine months before as a hard, painless mass, beneath the skin, fixed to the deep tissues. A short time after this the patient began to cough a little and raised some sputum which occasionally showed a trace of blood. The tumor gradually increased in size, but remained painless. For two months before admission there had been a dragging pain in the left upper quadrant of the abdomen, not associated with any gastro-intestinal symptoms. There had been marked loss of weight and strength, particularly during the last few months. During this same time, the cough ceased. About one month before admission, a swelling was noticed in the left axilla.

The physical findings on admission showed a young Chinese male, rather pale and emaciated. There was a prominent tumor over the right portion of the thoracic wall about seven by fifteen centimetres in diameter, apparently fixed to the fifth, sixth, and seventh right ribs. The skin over it was normal and freely movable. The tumor itself was hard and lobulated. There was dullness over the right lung with increased tactile fremitus and diminished breath sounds. In the right axilla there were several large, hard glands. The blood Wassermann reaction was negative. The blood count showed four million red blood-cells with 57 per cent. hæmoglobin, and 11,400 white cells with a normal differential count. Röntgen-ray examination of the chest showed evidence of metastatic deposits in the right lung. The fifth, sixth and seventh ribs were obscured by the dense tumor. A clinical diagnosis of osteosarcoma of the ribs was made. An axillary gland was removed for study which showed that the tumor was composed of spindle cells with rounded nuclei and many mitotic figures. The pathologic diagnosis was fibrosarcoma.

No treatment was instituted. The patient was discharged December 13, 1924, unimproved. No follow-up report is available.

CASE II.—A Chinese male, thirty-eight years of age, was admitted to the hospital on the neurologic service June 15, 1925, complaining of inability to walk for fifteen months. About four years before, he had begun to have shooting pain around the

waist and chest. Two years later the pain became very severe and he had to go to bed, and, after about two weeks, numbness of the legs was noted. In May, 1924, the legs became completely paralyzed and sphincter disturbances occurred.

On examination the patient was seen to be well developed and moderately well nourished. There were all the signs of a transverse myelitis with paralysis of both lower extremities, and there was almost complete anaesthesia below the level of the umbilicus, with a narrow girdle of hyperaesthesia just above the umbilicus.

Over the right side of the back, close to the spine and at the level of the seventh rib, was found a hard, bulging mass the size of a fist, adherent to the deep tissues, the skin over it being free. There was no fluctuation, no pulsation, no signs of inflammation, and only slight tenderness on pressure. There was no scoliosis or kyphosis. Except for this mass, nothing striking was noted on physical examination.

Röntgen-ray examination on June 17, 1925, showed complete destruction of the body, laminae, transverse processes and spinous process of the seventh thoracic vertebra,



FIG. 1.—Case II. Tumor of seventh thoracic vertebra with compression of the cord.



FIG. 2.—Case III. Tumor of eleventh rib, right, with compression of the cord.

leaving but slight trace of debris between the sixth and eighth vertebrae. There was also complete destruction of the seventh rib on the right side from the head outward to the mid-scapular line. The sixth and eighth ribs appeared normal. The spine showed no kyphosis nor lateral deviation. The lungs showed no signs of metastases though there was some evidence of thickening of the pleura (Fig. 1).

The Wassermann reactions of both the blood and the spinal fluid were negative. Combined cistern and lumbar puncture demonstrated a complete block of the spinal canal. The spinal fluid showed six cells above the block and eight cells below. The blood findings were normal.

A careful search was made for evidences of a primary tumor elsewhere, but, as none could be found, a diagnosis of primary tumor of the seventh thoracic vertebra was made. The patient was discharged without treatment. The further course of his disease is not known as he could not be traced after discharge from the hospital.

CASE III.—A Chinese male, eighteen years of age, was admitted on the neurologic service of the hospital November 3, 1926, complaining of inability to walk and a lump on the back. He had apparently been well until three months before when he began to

## TUMORS OF WALL OF THORAX

notice numbness starting in the toes and extending by degrees up to the hips. The legs gradually became weaker and for two weeks there had been complete paralysis of both lower extremities and of the sphincters. At the same time that these symptoms developed he noticed a lump in the middle of his back which slowly increased in size, but without pain. There was no history of injury.

On examination the patient was found to be well developed and nourished. He had the signs of a complete transverse myelitis at the level of the first lumbar segment, with paralysis and anaesthesia below the level of the hips. Over the right side of the back near the spine was a firm, rounded tumor, the size of a fist, apparently attached to the eighth, ninth and tenth ribs. It was very firm, non-tender, and the skin over it was freely movable. There was no frank scoliosis or kyphosis.

Röntgenologic examination showed a dense shadow of a conglomerate mass, roughly spherical in shape and about nine centimetres in diameter, lying to the right of the vertebral column at the level of the eleventh rib. It appeared to lie in the thoracic wall and its density was greater than that of neighboring bone. This mass pressed against the right side of the bodies of the tenth, eleventh and twelfth thoracic vertebrae, and deformed them, particularly the eleventh. The spinal ends of the tenth, eleventh and twelfth ribs on the right side were more or less obscured. There was pathologic fracture of the tenth rib. The radiologist made a diagnosis of osteogenic, malignant tumor of the spinal end of the eleventh rib, right, with secondary involvement of the thoracic vertebrae. The lung fields seemed to be clear (Fig. 2).

The examination of the spinal fluid showed a yellowish fluid from the lumbar puncture with six cells, and 6.4 milligrams protein. There were signs of a complete block of the spinal canal. The Wassermann reaction and the Kahn test were negative. The blood examination showed slight anaemia. During his stay in the hospital, there was progressive increase in the patient's neurological signs, and he began to lose weight.

Operation and radiation were thought to be inadvisable in this case and the patient was discharged without treatment. His course was not followed after he left the hospital.

CASE IV.—A Chinese woman, aged twenty-six, entered the hospital October 22, 1928, complaining of a large, firm mass in the left axillary region, of four years' duration. The tumor was first noticed as a small, hard nodule which apparently came on spontaneously and within a short time was said to have grown to the size of a walnut. During this time there was no pain. The patient could not give a very clear account of the rate of growth, but apparently it was rather slow until seven months before admission when there was rapid increase in size associated with some pain. There had been no fever or chill, no cough, and no loss of weight. There was slight disability in the left arm.

On examination, the patient was found to be well developed and nourished. A rounded mass could be seen protruding in the left anterior axillary line at the level of the second, third, and fourth ribs. On palpation this tumor was smooth, somewhat nodular and stony hard. The skin and subcutaneous tissues moved freely over the tumor, but the mass was firmly fixed, apparently to the bony structures of the thoracic wall.

The excursions of the wall of the chest during respiration seemed equal on the two sides. The tactile fremitus over the upper left lung, both front and back, was diminished, the percussion note was impaired, and the breath sounds decreased. Otherwise, nothing abnormal was found.

The urinalysis was negative. The blood examination showed normal findings. The Wassermann reaction and the Kahn test were both negative. The patient ran a slight fever up to 38° C. or slightly higher in the evenings, for which no cause could be found. The clinical diagnosis was osteoma or chondroma of the ribs.



Röntgen-ray examination gave very striking findings (Fig. 3). The right lung was clear. On the left side the entire lung field from the apex to the fifth rib anteriorly was occupied by a large mass of great density. Part of this mass lay outside the thoracic cage, but the major portion was within. The upper ribs were so obscured that the point of origin could not be determined. The tumor was lobulated, the surface somewhat granular, and in parts, the calcification was very irregular.

The patient was operated upon October 30, 1928, under intratracheal ether anaesthesia. A curved incision was made, and a skin-muscle flap raised and turned upward. The extrathoracic portion of the tumor was much larger than was anticipated, reaching up under the clavicle and high into the axilla. It was impossible to tell where it arose, but it was intimately adherent to and surrounded the first, second and third ribs. The pleural cavity was opened by dividing the second rib, and a small amount of

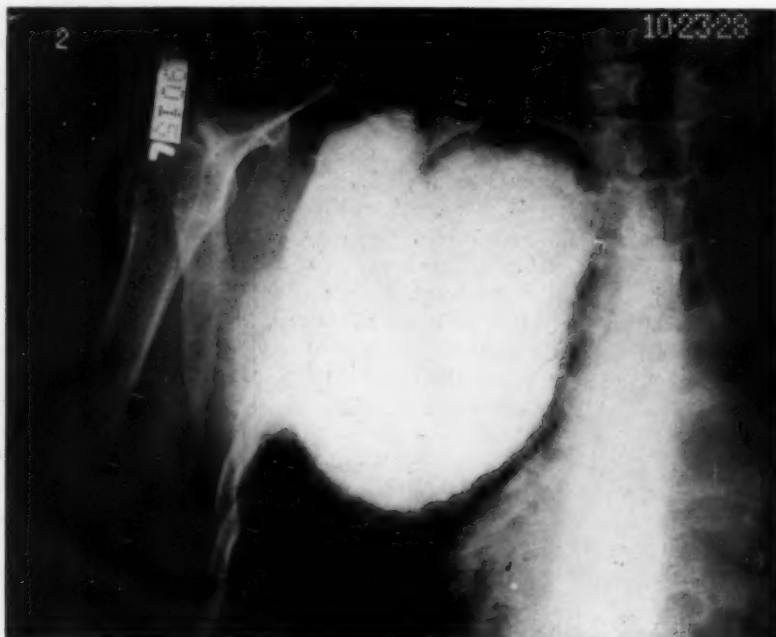


FIG. 3.—Case IV. Osteoma of second rib, left.

clear, yellowish fluid was obtained. The tumor was found to fill the entire upper half of the pleural cavity, reaching well up into the apex and nearly to the mediastinum. There were a few filmy adhesions between it and the lung. The tumor was removed by dividing the first, second and third ribs and the chest wall in front of and behind the tumor. Exposure was very difficult especially in the axilla and around the first rib, but fortunately neither the axillary structures nor the subclavian vessels were injured. There was some shock just as the tumor was removed. Where the tumor came in contact with the lung, there were two firm, oval, calcified nodules about two by two by five millimetres apparently in the visceral pleura. These were not disturbed. In removing the tumor, about three and one-half centimetres of the first rib and about fifteen centimetres each of the second and third ribs were removed. The defect in the chest wall was covered with the skin-muscle flap which was sutured in layers with interrupted silk. The lung was expanded just before the final suture was tied. A pressure dressing was applied. Three hundred and fifty cubic centimetres of whole blood was given before the patient was returned to the ward.

## TUMORS OF WALL OF THORAX

For several days the patient had moderate fever, which then subsided. There was some effusion of fluid into the pleural cavity, which was aspirated several times, from 200 to 400 cubic centimetres being obtained each time. The chest was kept well strapped for several weeks and then a chest binder fastened with straps and buckles was used. The lung gradually expanded. The patient was discharged November 20, 1928. Her only disability was pain in the left arm and shoulder, and inability to raise the arm well. She was seen in December, 1928, and in January and March, 1929 (Fig. 4). The last report from the patient in November, 1929, stated that she was still unable to lift the arm well.

The specimen consisted of a large, nodulated, very hard tumor mass sixteen by fourteen and one-half by twelve and one-half centimetres. It weighed 1,230 grams and had a specific gravity of 1.54. On the surface were many nodules, and three segments



FIG. 4.—Case IV. Osteoma of rib, three months after operation.



FIG. 5.—Case IV. Osteoma of rib, bisected, showing cut surface.

of ribs were firmly held. The tumor was sawed in two (Fig. 5) with some difficulty because it was so hard. The cut surface showed that the tumor was made up of nodules of hard, osteoid tissue joined together by fibrous tissue. The first and third ribs were encircled by the hard tissue while actually not attached to it, but the second rib could not be seen in the cut section, the tumor apparently having arisen from it, and completely replaced it.

The microscopic examination showed that the tumor was composed of bone trabeculae running in all directions, the structure resembling that of cortical bone. The fibrous stroma was made up of rather dense connective tissue with poorly straining, hyaline areas, and with numbers of stellate cells, some of which contained two nuclei. No mitotic figures were seen. The capsule was sharply marked and was composed of dense, partly hyalinized connective tissue. The pathologic diagnosis was osteoma (exostosis fibrosa; spongy type).

CASE V.—A Chinese farmer, fifty-one years of age, was admitted to the hospital September 20, 1929. Nine months before, he had accidentally noticed a hard tumor, the size of a walnut, on the left side of the chest, above and to the left of the nipple. One month later he developed shooting pains in the chest and down the arm. About the same time there developed cough with blood-streaked sputum, and the tumor began

to increase rapidly in size. The tumor was firmly attached to the thoracic wall from the beginning, but the skin was freely movable over it.

At the time of admission, the patient was rather emaciated and anæmic, and apparently was having continuous, rather severe pain. There was a prominent tumor, the size of a fist, above and to the left of the left nipple. The skin over it was normal and freely movable. The tumor itself was irregular, hard, and fixed firmly, apparently to the bony structures of the chest wall.

On percussion there was dullness over the entire left lung field with bronchial breathing, but no râles were heard. There was moderate cough with a small amount of blood-streaked sputum.

The blood showed three million red cells with 65 per cent. hæmoglobin, and 6,800 white cells with a relative lymphocytosis. The Wassermann reaction and the Kahn test were both negative. The Röntgen-ray examination demonstrated destruction of the anterior portion of the third, fourth, fifth and sixth ribs, and a rather dense, homogeneous shadow over almost the entire left lung field which was taken to indicate pleural and probably pulmonary involvement by tumor. A diagnosis of sarcoma of the thoracic wall was made, and the patient was discharged without treatment.

CASE VI.—A Chinese carpenter, aged twenty-three, was first admitted to the hospital May 4, 1929, because of a tumor of the right lower chest of one year's duration. It was first noticed immediately after a fight and was firm, slightly painful, and the size of a hen's egg. It increased gradually in size. No other symptoms were noted. There was no cough, and no loss of weight. The tumor was firm, round, and fixed to the thoracic wall, ten by fourteen centimetres in size. The skin over it was freely movable but showed some enlarged veins (Fig. 6). The Röntgen-ray examination showed irregularity of the dome of the right diaphragm, but no evidence of direct connection of the tumor with either the ribs or diaphragm. During inspiration, it was noted by fluoroscopic examination that the tumor moved up with the thoracic wall while the diaphragm moved downward. The blood examination was normal. The Wassermann reaction and the Kahn test were both negative.

The patient was operated upon May 8, 1929, under intratracheal ether anaesthesia. An elliptical incision was made parallel to the ribs. The tumor was found to be somewhat dumb-bell-shaped, extending to the pleural cavity, pressing on the diaphragm and attached to it. In order to remove it, it was necessary to resect segments of the seventh, eighth and ninth ribs, together with a considerable area of pleura. The pleura was closed, the diaphragm was sutured to the intercostal muscles, and the whole was covered with a skin-muscle flap. After operation the patient had considerable temperature reaction and signs of atelectasis of the middle and lower lobes of the right lung with some pleural fluid. The temperature soon came down to normal, however, and the patient was discharged May 20, 1929.

The tumor was roughly dumb-bell-shaped, the outer portion measuring fifteen by thirteen by nine centimetres, the inner nine by seven by four and one-half centimetres. It was firm, consisting of coarse bundles of grayish-yellow tissue, and contained a few cysts. It had apparently arisen from the intercostal tissues, and at one area showed invasion of the cartilaginous portion of a rib. Microscopically, it presented the typical appearance of a fibrosarcoma.

September 4, 1929, the patient returned with a recurrence the size of a hen's egg, but he refused to enter the hospital.

December 7, 1929, he again returned, with the tumor now the size of a fetal head, ulcerated at the surface (Fig. 7). He was re-admitted to the hospital December 11, 1929, in fairly good general condition. The tumor was painless. It projected forward from the thoracic wall for six centimetres, and the circumference at the base was thirty-six centimetres. It was rather soft, seemed fluctuant, and adherent to the deep structures. The skin over the tumor was ulcerated.

## TUMORS OF WALL OF THORAX

The röntgenologic examination of the chest showed nothing abnormal except the resected ends of the seventh and eighth ribs. The blood examination gave normal findings.

The second operation was made December 17, 1929, under ether anaesthesia. After circumscribing the base of the tumor, a membrane which was thought to be the thickened pleura was opened, but it gave entrance to the peritoneal cavity, the diaphragm being adherent to the ribs above the tumor. The tumor was then removed by excising the entire thickness of the abdominal wall, portions of the cartilaginous ends of the ribs and a bit of the sternum. The pleural cavity was not opened. This left a wide defect in the epigastric region. By undermining the skin on both sides and making relaxation incisions in the mid-axillary line on each side, it was possible to approximate the skin and subcutaneous tissues, but there remained a defect in the peritoneum, muscle and fascia, about the size of a hand. This was covered with a layer of fascia lata from the right thigh which was sutured with interrupted silk to the peritoneum



FIG. 6.—Case VI. Fibro-sarcoma of thoracic wall. FIG. 7.—Case VI. Recurrent fibro-sarcoma.

and fascia on both sides. The skin flaps were then closed over the fascial transplant, and the relaxation wounds were covered with Thiersch grafts. Except for signs of atelectasis of the right middle lung and the lobes, and of possibly some bronchopneumonia, the patient made an uneventful recovery, and was discharged January 10, 1930. The tumor measured eighteen by twelve by ten centimetres. It presented much the same appearance as the original tumor except that it was more cellular and mitoses were more frequent. A diagnosis of fibrosarcoma was made.

The patient has not returned for examination. According to the patient's wife he was entirely well in May, 1930, and too busy working to have time to come to the hospital for examination.

CASE VII.—The following report is of a case in which the diagnosis was never clearly established between a vascular tumor of the sternum and an aneurism. The patient was a Chinese farmer, forty-seven years of age, admitted to the hospital March 8, 1928. He complained of severe pain in the chest and a tumor over the sternum. The pain began three years before, was severe and cutting in character, and the patient had become a morphine addict because of it. Ten months before admission

a tumor was noticed in the centre of the sternum. Within six months this tumor grew to the size of a hen's egg.

The tumor was seen as a prominent, bulging, purplish, pulsating mass, over or through the mid-point of the sternum at the level of the nipples and opposite the third, fourth and fifth ribs. Normal heart sounds could be heard in it but there was no bruit, shock or thrill. The heart was normal in size. The Wassermann reaction was strongly positive, but there were no other signs of tertiary syphilis. The röntgenologic examination was rather in favor of aneurism. There was, however, considerable difference of opinion amongst different observers as to whether it was a tumor or an aneurism. A radium pack was applied but there was no change in the tumor. The patient was discharged unimproved March 27, 1928. He did not respond to the follow-up letters sent two months and six months later.

CASE VIII.—This patient was operated upon at another hospital in Peiping, but the surgical specimen was brought to us for examination.

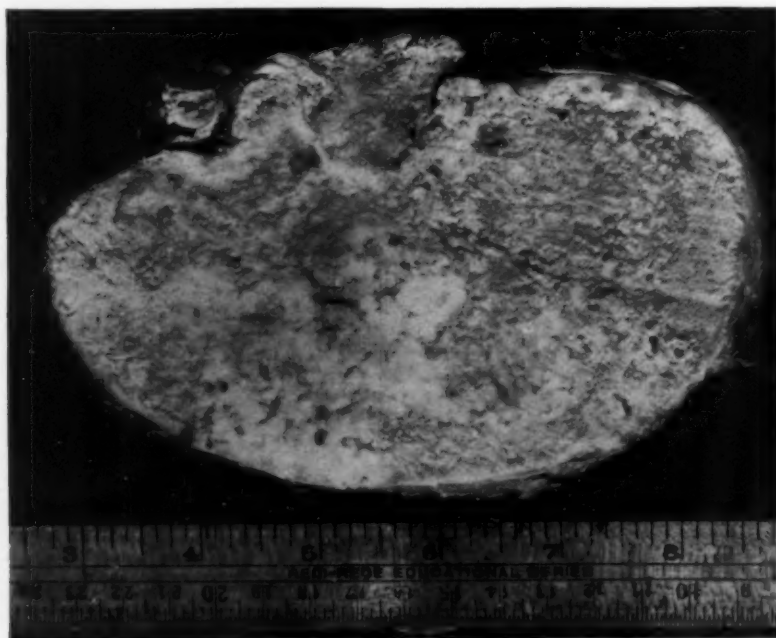


FIG. 8.—Case VIII. Chondro-sarcoma of ribs. Cut surface of surgical specimen.

The patient was a Chinese man, about twenty-five years of age, who had a large, painless swelling of the right lower chest of several years' duration. The tumor was the size of a large grapefruit. The röntgenologic examination showed that the tumor apparently arose from the seventh rib and a portion of it presented within the pleural cavity. It was apparently an osteochondroma (Fig. 8).

The patient was operated upon November 8, 1928, under intratracheal ether anaesthesia. In order to get exposure and remove the tumor it was necessary to resect three ribs and a considerable area of pleura. The defect was closed with the skin-muscle flap. The patient died rather suddenly about five hours after operation. The pathologic report was chondrosarcoma.

#### Group B

*Thoracic tumors arising in the subcutaneous tissues.*—In addition to the foregoing group of tumors which arose from the deep structures of the



## TUMORS OF WALL OF THORAX

thoracic wall, there have been seen in the Peiping Union Medical College Hospital other patients with tumors arising in the subcutaneous tissues. Excluding cases of lipoma, skin tumors, and tumors arising in the lymphatic glands, the following cases were seen and are here briefly reported. The clinical examination in some of these cases showed that the tumor was tightly adherent to the deep structures of the thoracic wall, but in all instances either the history or the operative findings indicated that the primary origin was superficial to these structures.

CASE IX.—A Chinese 'rickshaman, forty-eight years of age, was admitted to the hospital August 29, 1921, with the complaint of a tumor on the right side of the chest. This tumor first appeared in 1916 and ulcerated through the skin about six months after it was noticed. In April, 1918, it was excised, the specimen consisting of a flat mass about fourteen by eight by six centimetres with ulceration of the skin. Microscopic examination showed that it consisted of large and small round cells and spindle cells and a diagnosis of large round-cell sarcoma was made.

A small recurrence was noted in the out-patient department in January, 1920, and excision was recommended, but the patient did not return for admission. In August, 1921, however, he came back again and was admitted to the hospital. At this time the tumor was situated in the right mid-clavicular line just below the clavicle, and above the scar of the previous operation. It was about the size of a large apple, four by three by two and one-half inches, adherent to the skin, but movable over the deeper structures. It was rounded, soft, semi-fluctuant, non-tender on pressure, and painless. The axillary glands were not palpably enlarged. The lungs were clear except for a few moist rales. No Röntgen-ray examination was made.

The tumor was excised on August 31, 1921, together with a large area of skin, the pectoral muscles and fascia, and the axillary contents. The axillary glands showed no gross or microscopic evidence of metastases. The tumor itself was made up of large round and oval cells with a few giant cells. A diagnosis of sarcoma was made. The late end-result is not known.

CASE X.—A Chinese soldier, twenty-two years of age, was admitted to the hospital March 30, 1923, because of a recurrent tumor in the region of the right breast. At the age of ten years the patient received an injury to this area followed by ecchymosis of the skin. About two years later a small tumor was noticed in this same region. The lump was painless and grew slowly until it reached a size of two and one-half inches in diameter in about four years. At that time (1917) it was removed at a missionary hospital in Shantung Province—the left breast being removed with the tumor. The incision was sutured and healed in eight days. In 1922 a recurrence was noted about the size of a finger tip, which caused no symptoms and enlarged very gradually.

Examination revealed a young Chinese male, normal in appearance except for the presence of a bulging tumor over the left thoracic region, six by five by two and one-half centimetres in size, lying a little to the left of the mid-line, at the level of the right nipple. The left nipple had been removed and a long, transverse scar passed across the tumor. There were dilated blood-vessels visible in the skin over the tumor, and the skin was discolored a little. Near the apex of the tumor the skin was adherent to it, but the mass was freely movable over the deep structures of the chest. It was oval and very firm. The general physical examination was negative. The blood and urine were normal. No Röntgen-ray examination is recorded and there is no note of a Wassermann reaction.

A local resection of the tumor was done April 2, 1923, under general anaesthesia. A wide removal of skin was done. The tumor lay in the subcutaneous tissues and no

muscle or bone was removed. The denuded area was covered with Thiersch grafts which healed well, and the patient was discharged April 21, 1923.

The tumor was found to be encapsulated, and looked grossly like a fibroma. The microscopic examination showed that the tumor was made up of bundles of spindle cells which varied considerably in size and shape. Throughout the tumor were blood spaces apparently lined only by tumor cells. A diagnosis of sarcoma was made but endothelioma was also considered as a possibility. The late end-result is not known as the patient could not be traced after leaving the hospital.

CASE XI.—A Chinese soldier, thirty-one years of age, was admitted to the hospital February 26, 1924, because of a large tumor attached to the right side of his chest. The tumor was first noticed about a year before admission, at which time it consisted of a small firm nodule over the third right costal arch which seemed to be attached to the skin and was movable with it over the deep tissues. There was no history of

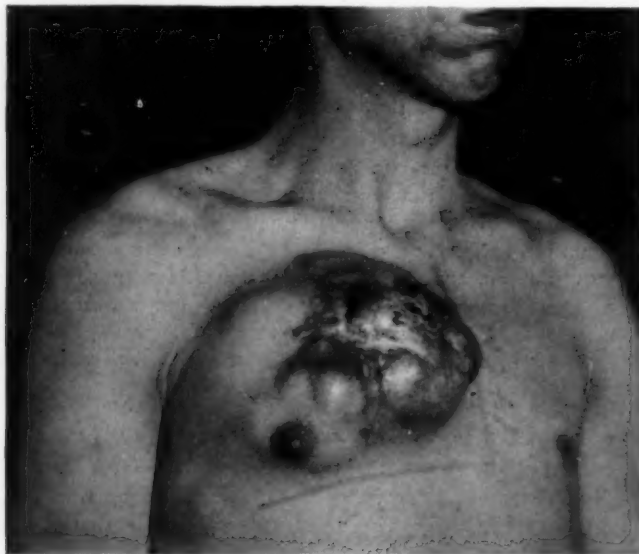


FIG. 9.—Case XI. Spindle and round-cell sarcoma.

injury. At first the tumor was painless, but as it grew it became very painful, the pain being constant and throbbing and so severe that the patient was unable to sleep. The growth was very rapid. About six months after the onset, the tumor was excised in an army hospital. The wound healed in seven days, but the tumor recurred within one month, grew more rapidly than before and was extremely painful. Within three months it had regained its previous size and was excised a second time. It recurred for the second time within a few weeks and was about ten centimetres in diameter when the patient was admitted to the hospital. The patient had some cough but no hemoptysis, and there had been no loss of weight or strength.

On examination the patient was found to be moderately well nourished but slightly anæmic. The prominent tumor projected from the right anterior aspect of the thoracic wall directly above the nipple (Fig. 9). It was about sixteen by fourteen centimetres in diameter, irregularly nodular and adherent to the skin at the old scar of the previous operations. It was firm in consistency throughout, and so firmly fixed to the thoracic wall as to be immovable on the deeper structures. The liver was just palpable. The clinical examination of the lungs was negative. No enlarged glands were felt. The röntgenologic examination showed no changes in the lungs,

## TUMORS OF WALL OF THORAX

pleura or ribs. The blood examination showed a slight anemia with a normal white blood count. The Wassermann reaction of the blood was negative. A portion of the tumor was removed for microscopic examination which showed that it was composed of large round cells in solid masses which were invading striated muscle. A few spindle cells were present. A diagnosis of mixed-cell sarcoma was made.

The tumor was regarded as inoperable. A superficial Röntgen-ray treatment was given February 29, 1924. The patient was discharged from the hospital March 1, 1924, but returned for further Röntgen-ray treatments on April 11, and again on April 26. These had no effect on the growth of the tumor. The general condition of the patient remained fairly good. During subsequent fighting the patient's battalion was lost and the few survivors could not be traced.

CASE XII.—A Chinese farmer, aged thirty-three, was admitted to the hospital June 6, 1928, because of a large, ulcerating tumor in the left mammary region. The tumor



FIG. 10.—Case XII. Fibro-sarcoma of chest wall.



FIG. 11.—Case XIII. Sarcoma of right axillary region.

had been first noticed sixteen years before as a small mass, the size of a walnut, above the left breast. In eight or nine years it grew to the size of a hen's egg, and continued to grow slowly, causing no symptoms, until the winter of 1926, when it began to increase rapidly in size. By July, 1927, it had attained the size of a small melon. The patient then began to notice weakness and exhaustion, anorexia and loss of weight. In February, 1928, the skin broke open and a deep ulcer with foul discharge appeared. There was no pain at any time.

Examination showed a young Chinese man moderately emaciated with a huge ulcerating tumor hanging from the left wall of the chest (Fig. 10). There were large dilated veins visible in the skin. The mass was particularly movable over the thoracic wall. The Röntgen-ray examination showed no evidence of destruction of the bones of the thoracic cage or any pulmonary metastases though the tumor itself obscured the left portion of the lung field so that an accurate estimate could not be made. The

blood examination showed three million red cells with 37 per cent. hæmoglobin, and a normal white cell count.

Under ether anæsthesia, the tumor, with a wide area of skin and a portion of the pectoral muscle, was excised with the cautery June 8, 1928. A portion of the wound was left open as there was insufficient skin to close it, and it was later covered with small deep grafts. The patient was discharged July 2, 1928. Microscopic examination showed typical fibrosarcoma.

According to a report made by the patient's relatives May 7, 1930, he was entirely well at that time.

CASE XIII.—A Chinese male, thirty-five years of age, was admitted to the hospital May 8, 1923, because of a mass over the right side of the chest and axillary region of six months' duration. The tumor was first discovered accidentally in the region of the right breast and was thought to be attached to the skin. It was hard and non-tender. A hard lump was next noted in the axilla and both grew until they coalesced to form a single, large, moderately firm, very slightly movable mass (Fig 11). Associated with this there developed first weakness, then numbness, and finally complete paralysis of the right arm. At the time of admission the tumor consisted of a large, rounded mass filling the right axilla, pushing the arm out from the side, and extending downward over the wall of the chest. No enlarged lymph-nodes were palpable. The blood examination and Wassermann reaction were negative. The röntgenologic examination of the chest showed evidence of metastases to the lungs, but no enlarged mediastinal glands. In view of these findings a diagnosis of sarcoma of the thoracic wall was made, as a tumor arising from the lymph-glands seemed unlikely. No treatment was attempted. The course after leaving the hospital is not known.

#### Group C

*Secondary growths.*—In addition to these tumors of the wall of the chest, which were all considered to be primary, there are in the Peiping Union Medical College Hospital records of another group of cases which are thought to be secondary. These will be very briefly reviewed.

CASE XIV.—An American girl, twelve years of age, was admitted to the hospital December 6, 1928, because of pallor, loss of weight, and some weakness of the left leg. The clinical and Röntgen-ray examinations were suggestive of pleural thickening and effusion into the left pleural cavity, presumably tuberculous in nature, and of early tuberculosis of the left hip-joint. Subsequent findings indicated that there was a malignant tumor of the pleura with multiple metastases to the bones of the pelvis, both femora, and the vertebral bodies. There was also direct extension through the wall of the chest, a rounded mass, apparently attached to the left fifth rib, being palpable for several months before death, which occurred February 8, 1929.

CASE XV.—A Russian male, forty-five years of age, was admitted January 24, 1924, because of pain in the left chest, dyspnoea, and cough with sputum for nine months. In addition to flatness over the left side of the chest, there was present a conical tumor ten by seven centimetres at the postero-lateral aspect of the chest, a little below the angle of the scapula. This was firm, immovable, and apparently attached to the thoracic wall. Autopsy showed a tumor involving practically the entire left lung with extension to the pleura, ribs, and intercostal muscles. The tumor proved to be a mesothelioma. There was also extensive tuberculosis of both lungs.

CASE XVI.—A Chinese woman, fifty years of age, was first admitted to the hospital December 6, 1922, with vague abdominal pains which were diagnosed as being due to chronic gastritis. She was discharged January 8, 1923. She was re-admitted March 3, 1923, because of pain in the back and left shoulder. On this occasion there was a hydrothorax on the left, with enlarged glands in the left supraclavicular region. One

# TUMORS OF WALL OF THORAX

of these glands was removed, and microscopic examination showed carcinoma. The primary tumor could not be definitely located. The patient left the hospital April 20, 1923.

She returned to the hospital again October 30, 1923, this time with a tumor the size of an apple in the posterior axillary region of the left side, adherent to the deep structures, and nodules in the left fourth rib anteriorly. Röntgen-ray examination showed partial destruction of the left scapula, the left humerus, and the left seventh and eighth ribs, apparently due to metastatic carcinoma. The primary tumor was never located.

## Cases collected from the literature 1929-1930

Author	Date	Age	Sex	Right or Left	Origin	Pathology	Treatment	Result
1. Mole <sup>6</sup>	1928	37	M	R	Ribs	Chondroma	Excision	Well—immediately
2. Lyle <sup>6</sup>	1928	20	F	R	Soft tissues	Hemangioma	Excision	Well—immediately
3. Hess <sup>7</sup>	1926	49	F	L	Ribs?	Fibro-lipoma	Excision	Well—immediately
4. Lockwood <sup>8</sup>	1928	50	F	R	Ribs	Chondro-sarcoma	Partial excision, radiation	Recurrence (two times)
5. Lockwood <sup>8</sup>	1928	26	M	R	Soft tissues?	Round-cell sarcoma	Partial excision, radiation	Unimproved
6. Harrington <sup>9</sup>	1927	18	M	L	Ribs	Osteo-fibro-sarcoma	Radical operation	Well 17 months
7. Harrington <sup>9</sup>	1927	13	F	L	Ribs	Osteo-sarcoma	Partial resection, radiation	Recurrence, Death
8. Harrington <sup>9</sup>	1927	15	F	R	Ribs and pleura	Endothelioma	Partial resection, radiation	Recurrence, Death
9. Harrington <sup>9</sup>	1927	3	F	R	Ribs	Osteo-genetic sarcoma	Partial resection, radiation	Death 9 months
10. Harrington <sup>9</sup>	1927	58	M	R	Ribs	Chondro-sarcoma	Resection, Radium	Well 8 months
11. Harrington <sup>9</sup>	1927	54	M	R	Ribs	Chondro-sarcoma	Resection, Radium	Well 18 months
12. Harrington <sup>9</sup>	1927	42	M	L	Ribs?	Lympho-sarcoma	Resection, Radium	Well 11 months
13. Harrington <sup>9</sup>	1927	45	M	L	?	Fibro-sarcoma	Removal, radium	Well 11 months
14. Harrington <sup>9</sup>	1927	46	F	L	Secondary to breast tumor	Lympho-sarcoma	Radical resection, radium	Well 14 months
15. Harrington <sup>9</sup>	1927	29	F	R	Ribs	Fibro-myxo-sarcoma	Radical resection, radium	Well 3 months
16. Harrington <sup>9</sup>	1927	44	F	R	Rib	Old healed fracture?	Resection	Well
17. Harrington <sup>9</sup>	1927	57	F	R	?	Tuberculous abscess	Drained	Well
18. Harrington <sup>9</sup>	1927	29	F	R	Rib	Exostosis	Removal	Well
19. Harrington <sup>9</sup>	1927	37	F	L	Rib	Achondrosis of cartilage	Removal	Well
20. Harrington <sup>9</sup>	1927	32	F	R	Rib	Areas of necrosis of cartilage	Removal	Well

A chart showing the cases collected from the literature is appended. I am indebted to Dr. C. K. Hsieh, of the Department of Röntgenology, for his interpretation of the Röntgen-ray films and for his helpful suggestions.



M. M. ZINNINGER

BIBLIOGRAPHY

- <sup>1</sup> Hedblom, C. A.: Tumors of the Bony Chest Wall. *Arch. Surg.*, vol. iii, p. 56, 1921.
- <sup>2</sup> Parham, F. W.: Thoracic Resection for Tumors Growing from the Bony Wall of the Chest. New Orleans, 1899.
- <sup>3</sup> Lund, F. B.: Sarcoma of the Chest Wall. *ANNALS OF SURGERY*, vol. lviii, p. 206, 1913.
- <sup>4</sup> Heuer, Geo. J.: Nelson's Loose-leaf Living Surgery. Thos. Nelson and Sons, New York, vol. iv, p. 417, 1927.
- <sup>5</sup> Mole, R. H.: Notes on Some Recent Interesting Tumors. *China M. J.*, vol. xlii, p. 840, 1928.
- <sup>6</sup> Lyle, H. H. M.: Hæmangioma of Chest Wall. *ANNALS OF SURGERY*, vol. lxxxviii, p. 668, 1928.
- <sup>7</sup> Hess, Geo. H.: Subpleural Fibrolipoma. *Radiology*, vol. vi, p. 525, 1926.
- <sup>8</sup> Lockwood, C. D.: Malignant Tumors of the Wall of the Chest. *Arch. Surg.*, vol. xvii, p. 457, 1928.
- <sup>9</sup> Harrington, S. W.: Surgical Treatment of Intrathoracic Tumors, and Tumors of the Chest Wall. *Arch. Surg.*, vol. xiv, p. 406, 1927.

## SARCOMA OF THE BREAST

BY RIGNEY D'AUNOY, M.D. AND ROY W. WRIGHT, M.D.

OF NEW ORLEANS, LA.

FROM THE DEPARTMENT OF PATHOLOGY AND THE HOUSE SURGICAL SERVICE OF CHARITY HOSPITAL OF NEW ORLEANS

THE pure connective tissue type of malignancy of the breast is rare. In this paper, we record (Table I), the eleven cases of sarcoma of the breast that have occurred at the Charity Hospital of Louisiana during the last twenty-five years, and briefly review the literature relative to the subject.

*Incidence.*—Williams, in 1892, reported that in a series of 2,422 breast neoplasms, 3.5 per cent. were sarcomatous. In a group of 12,823 primary tumors, he found 1,081 sarcomas, ninety-nine of which were of the breast, thus giving breast sarcomas an incidence of 0.17 per cent. of all recorded tumors. Winslow, in 1911, reviewed a series of 100 cases of tumors of the breast occurring in the University Hospital of Baltimore and found that sixty-three were carcinomas, three sarcomas, twenty fibro-adenomas, one a pericanalicular myzoma, five cystic fibro-adenomas, two galactoceles, three tuberculous mastitis and three abscesses. Thus, in this series, 63 per cent. of the cases were carcinomas and 3 per cent. sarcomas. In 1921, the same author reviewed 102 cases of breast tumors seen in the same hospital in the preceding three years, and of these 59.8 per cent. were carcinomas and 2.94 per cent. sarcomas. Deaver, in 1917, cited 838 cases of sarcoma of the breast in the literature, and stated that this figure is probably somewhat incorrect due to difficulties afforded by careless and faulty classifications. He further states that the fifteen cases of breast sarcoma which came to operation at the Lankenau Hospital represented 2 per cent. of the total of breast tumors observed at that institution in a period of sixteen years. Porter, in 1920, published a study of seventy-seven breast tumors which he had observed personally. Forty-nine were malignant, one being a sarcoma. Ewing quotes Rodman to the effect that in a series of 5000 cases of breast tumors, 2.78 per cent. are sarcomatous. Fischer, in a series of 300 breast specimens received at the Pathological Institute at Rostock, from April, 1922, to May, 1925, found 152 carcinomas and one sarcoma.

In our studies of the literature relative to sarcomatous tumors of the breast, we find the last detailed review to be that of Geist and Wilensky, in 1915. They reported twenty-two cases, and, including these, collected 435 breast sarcomas from the literature. We have been able to find fifty-seven cases reported since this review, and add the eleven cases which have been recorded at Charity Hospital during the last twenty-five years. We have not included cases where the author was not entirely certain of the nature of the tumor, nor of the fact that it was not a secondary growth or part of a generalized sarcomatosis. We found several such instances recorded under

TABLE I  
Cases of sarcoma of breast occurring at Charity Hospital, New Orleans  
1904-1929

Hospital No.	Age	Sex	Location and known duration of tumor	Treatment	Pathological type	Metastases and recurrences	Comments
C.H. 102-153	42	F.	Right. Several months.	Radical amputation	Round-cell	Asiillary glands not enlarged	Made good post-operative recovery.
C.H. 154-153A	30	F.	Right. Fifteen years with rapid growth for last few months.	Radical amputation	Fibro-myxo-sarcoma	Enlarged axillary glands	Good post-operative recovery. Noteworthy for long duration.
C.H. 273-153A	30	F.	Left. Fourteen months.	Radical amputation	Cysto-sarcoma	Enlarged axillary glands	Post-operative recovery.
C.H. 232-153A	75	F.	Left. Eight years with rapid growth in last year.	Mammectomy	Fibro-sarcoma		Post-operative recovery.
C.H. 206-153A	23	M.	Right. Six months.	Mammectomy	Oat-cell sarcoma		Tumor dates to trauma six months previously; hit in the breast with doorknob, at which time swelling and inflammation with pus formation occurred.
C.H. 298-153B	59	F.	Left. Several months.	Mammectomy	Mixed-cell sarcoma	Enlarged axillary glands	Post-operative recovery.
C.H. 418-153C	55	F.	Right. Eight months.	Radical amputation	Sarcoma	Enlarged axillary glands	Post-operative recovery.
C.H. 542-153E	49	F.	Left. Two years.	Mammectomy	Fibro-sarcoma		Post-operative recovery.
C.H. 522-153E	46	F.	Right. Nine years.	Mammectomy	Chondro-sarcoma		Post-operative recovery.
C.H.	37	F.	Right. Thirteen years with more rapid growth in last year.	Radical amputation	Fibro-myxo-sarcoma		Post-operative recovery.
C.H. 17281	39	F.	Left. Three months.	Radical amputation	Lympho-sarcoma	No evidence of metastasis	Good post-operative recovery.

## SARCOMA OF THE BREAST

the title of sarcoma of the breast. Thus we bring the number of recorded cases of authentic mammary sarcoma to 503 cases. Our search reveals, further, that during the last twenty-five years, 1035 cases of mammary carcinoma have occurred at Charity Hospital and during the same period there have been eleven authenticated cases of mammary sarcoma, making a total of 1046 breast malignancies, 0.1 per cent. of which were sarcomatous.

*Etiology.*—As with other types of malignancy, we are not able to establish any definite etiology for breast sarcomas. However, it is a well-recognized clinical fact that the existence of benign tumors of the breast may be looked upon as etiologically significant in the production of malignancy. While secondary malignant changes in such benign growths are usually of a carcinomatous nature, they may naturally occur in the connective tissue elements of the organ with production of a sarcomatous tumor. Consensus of opinion, as expressed in the reports which we have studied and as early pointed out by Labbe and Coyne, ascribes such "malignant metamorphosis" within a preëxisting fibroma or adeno-fibroma as the most important factor in the production of mammary sarcoma. Ribbert, Wilms, Burkard and Letulle stress the etiological importance of congenital anlage displacements and snipped-off fetal parts.

In the vast majority of cases the patients give a history of a symptomless, stationary tumor of many years' duration (forty years in a case reported by Sutton), which suddenly takes on rapid growth. From our study we are in agreement with the opinion of numerous authors that trauma is not a very important etiologiical factor in the production of mammary sarcoma, although in a few instances it must be considered, as for example, in Case V of our series.

*Age Distribution.*—Regarding age, Flynn says that "sarcoma of the breast differs from sarcoma of other regions in that it occurs most often between the ages of forty and sixty." Bindi states that "sarcoma of the breast usually develops in young women, being less often seen in children, and rarely at an advanced age." Finsterer (quoted by Speese), notes that the average age when sarcoma of the breast develops in men is 45.6 years, being practically ten years earlier than the average age of development of mammary carcinoma in the same sex. Greenough and Simmons find that mammary sarcoma occurs at a period later in life than the periductal fibroma. With this latter, the average age of occurrence according to their statistics was 28.8 years, while the average age of occurrence of the frank sarcoma was forty-nine years. In the series of cases from the Charity Hospital, we find twenty-three to be the youngest age, seventy-five years the oldest, with an average age incidence of 44.15 years.

Naturally, mammary sarcoma, as with all forms of breast pathology, is overwhelmingly more abundant in the female than in the male. In the fifty-seven cases of this tumor which we have collected from the literature since 1915, four cases occurred in males. In the series of eleven cases which we report from Charity Hospital, one was in a male. Many authors

state that pregnancy and lactation seem to have no important relationship to the origin of these tumors. If such be the case, it would then seem justifiable to attribute the high female sex incidence to the fact that benign breast tumors are so much more frequent in the female.

*Pathology.*—It is impossible to briefly state even the salient facts concerning the pathologic anatomy of the group of tumors classed as mammary sarcoma. The reason for this is evident when we consider the occurrence in the breast of teratoid growths and of mixed tumors, such as adeno-fibromas and adeno-sarcomas and the so-called pseudo-sarcomas. Excluding such growths, the formidably complex group dwindles to a comparative few, well-defined tumor types. As Ewing points out, such a disintegration of the group is most desirable. Still, the situation remains much the same as it was in 1894, when, because of the absence of required data and because of the form in which the little available data was present, Williams found it impossible to write a complete review of pure sarcoma of the breast.

From our personal experience and after critically reviewing and considering the pathology in the cases we have studied, we feel that an all-inclusive classification, however desirable, cannot be arrived at, and believe it best at present to limit the group to the pure sarcomas, represented by such rather distinct types as spindle-celled, round-celled, and polymorpho-celled growths—and even of these only the pure spindle-cell tumors approximate a well-defined type—and the adeno-sarcomas.

The adeno-sarcomas, even though a rather specific form of mixed tumor, are of extreme importance etiologically in considering the group of mammary sarcomas, as it is entirely probable, as Delbet first suggested, and as is now believed by many authors, that they have the same origin as most pure sarcomas, at least the true spindle-cell types, eventuating as a result of malignant transformation of fibro-adenomas. The true adeno-sarcoma presents many variations in structure and is comparatively rare, being often mistaken for a rapidly growing carcinoma with anaplastic spindle-shaped or round cells grouped about the hypertrophied ducts.

Of the pure mammary sarcomas, the spindle-cell type comprises a rather well-defined group. With these, cyst formation is prominent, and combination with other tissue types has been noted. Histologically, their diagnosis is not simple, as very often atypical carcinomas present large areas of spindle-shaped cells. Tumors of this general type presenting marked or short spindle cells are by far the most malignant.

The round-cell sarcomas comprise an ill-defined group in so far as nature and structure are concerned. Again, many growths so classed are atypical carcinomas.

*Metastasis.*—Regarding metastasis in mammary sarcoma, Denk states that the axillary lymph-glands may become involved but that their involvement is less common than in carcinoma. Flynn says that breast sarcomas are very vascular, but practically without lymphatics, so that they metastasize through the blood-stream. Geist and Wilensky found thirteen cases in



## SARCOMA OF THE BREAST

which there was histological involvement of the lymph-nodes, and state that 37 per cent. of cases show recurrences, and 15 per cent. show metastasis. In many instances in which the axillary glands were found to be enlarged, they have shown no histological evidence of malignancy, and it is to be remembered that sepsis from the tumor may produce glandular hyperplasia, which is not due to metastasis. In the sixty-eight cases which we have studied, there was histologically proven metastasis to lymph-nodes in four instances and to the lungs in two.

Geist and Wilensky state that 31 per cent. of their series of 435 cases were spindle-cell sarcomas, 14 per cent. round-cell sarcomas, 12 per cent. cysto-sarcomas, while fourth in frequency were the adeno-sarcomas. Of the cases we reviewed there were more spindle-cell types than any other type.

*Clinical aspects, symptoms and diagnosis.*—Consensus of opinion seems to favor the view that sarcomas of the breast may remain stationary in size for months or even years after first noticed, and that when growth ensues, it is, as a rule, very rapid, the tumor usually attaining gigantic proportions before the patient comes under the observation of the surgeon. Hamann states that typically the tumor is partly cystic and partly solid, and that the axillary glands are not as a rule involved. While early diagnosis may be difficult, he feels that "a large tumor of the breast, partly cystic, and partly solid, not adherent to the skin and with no axillary adenopathy, is probably sarcomatous."

Denk, from his study of diseases of the mammary gland, concludes that the general health of the patient is usually less impaired in sarcoma than in carcinoma of this organ, in spite of the often more rapid growth of the former, which, in the presence of cystic softening, may reach the size of an average head. He says that diagnosis in the early stages is difficult, but that in the advanced stage the very large tumor, partly cystic and partly solid, covered by a thin, slightly reddened skin, traversed by dilated veins, with free axillary glands, gives a characteristic picture. Flynn is of the same opinion.

Antonioli, in his very thorough and excellent treatise on bleeding breasts and breast tumors, says that with sarcoma, bleeding has been seen in cases which developed polycystic degeneration. He states that Gross, in examining 156 sarcomas of the breast, concluded that in the solid types of sarcoma there is neither hæmorrhagic nor serous secretion from the nipple, but that there may be secretion either hæmorrhagic or serous in the cystic types of sarcomas. He collected seventy-eight such cases. Other authors who are quoted by Antonioli as having reported cases of mammary sarcoma in which bleeding or secretion from the nipple was an important clinical sign, are Billroth, Winslow, Huter, Lebert and Verneuil. Antonioli adds that among twelve cases of cysto-sarcoma studied by Bryant, four showed a distinctly hæmorrhagic secretion. In two cases the secretion was the first symptom, and preceded the appearance of the tumor by three months in one case, and two years in the other. He agrees with other observers, however, that

bleeding or secretion from nipples is not pathognomonic of any disease, being present in a certain proportion of benign as well as malignant new growths, especially those undergoing polycystic degeneration, or, as an evidence of complementary hæmorrhage. In the cases which we have studied, we have found bleeding from the nipple mentioned only twice.

Flynn calls attention to the fact that in sarcoma of the breast, the nipple is rarely retracted, the skin is never adherent to the tumor, but that ulceration of the skin occurs early and the tumor seemingly hangs away from the chest wall and is freely movable.

All authors agree that histological examination is the only certain method of diagnosis of this tumor, since many clinically benign tumors will, when subjected to careful histological study, reveal sarcomatous areas, and that there are no pathognomonic signs nor symptoms to distinguish the condition clinically from carcinoma.

*Treatment.*—Sarcoma of the breast is purely a surgical condition. Winslow states that "this condition is malignant and should be treated in as radical a manner as carcinoma." Hamann considers "radical amputation, including removal of the pectoralis major, minor and axillary adenectomy, as the operative procedure of choice." He adds that some authors contend that axillary dissection is superfluous, since axillary metastasis is not the rule. He feels, however, that "since at the time cellular characteristics and degree of malignancy cannot be determined pre-operatively, and since the radical operation will include a more thorough removal of the surrounding vascular connections, it seems the logical choice." Denk is of the opinion that the treatment of mammary sarcoma is the same as that of mammary carcinoma, radical amputation being the operation of choice, with end-results about the same. Flynn likewise recommends the radical operation.

Since the vast majority of the cases recorded are reported almost immediately after operation, it is impossible to make a statement based on clinical observations as to whether or not the radical amputation offers any advantage over the simple mastectomy. In view of the malignant nature of the disease, we feel, however, that radical amputation should be the procedure of choice.

*Prognosis.*—We find it difficult to draw conclusions regarding the prognosis of mammary sarcoma from the reports of cases occurring in the literature, due to the fact that the vast majority of cases are reported immediately after operation, and the ultimate outcome not recorded. Elliott states that fibromas tend to undergo myomatous degeneration and may develop into periductal sarcomas. He adds that "fortunately, such sarcomas are not very malignant, or are only locally so, for their complete removal usually affects a cure." Caylor and Shugrue report a case of a fibro-sarcoma developing in a fibro-adenoma in a male and mention a similar one recently seen in a female. They feel that these tumors were of a low grade of malignancy. They state that Connell reported eleven cures in thirty-four cases of all kinds of sarcoma of the breast in men. Finsterer, in 1906, reported only

## SARCOMA OF THE BREAST

one cure in twelve cases. Geist and Wilensky found that the cystic type of sarcoma of the breast offered the better prognosis, 75 per cent. being cured, whereas with the solid type of tumor, the mortality was as high as 42 per cent. Flynn states, "sarcoma of the breast is generally recognized to be second only to carcinoma as the most malignant pathological lesion of the breast."

### BIBLIOGRAPHY

Here are included only a few general references and all references to authenticated cases of sarcoma of the breast appearing in the literature since 1915:

- Antonioli, G. M.: Hemorrhage of Breast and Breast Tumor. *Minerva Med.*, vol. vi, p. 1090, 1926.
- Baldwin, A.: Case of Angio-sarcoma of the Breast (Right). *West Lond. Med. J.*, vol. xxii, p. 132, Lond., 1917.
- Eatzdorff, E.: Sarcoma. *Beitr. z. klin. chir.*, vol. cxxxix, p. 199, 1927.
- Bergeret and Botelho: Epithelio-sarcoma of Mammary Gland. *Gynec. et Obst.*, vol. i, p. 139, 1920.
- Biebl, M.: Relation of Sarcoma to Fibrosis. *Beitr. z. klin. chir.*, vol. cxl, p. 52, 1927.
- Bindi, F.: Dermoid Cyst and Sarcoma of Breast. *Gazz. d. Osp.*, vol. xxxix, p. 87, 1918.
- Bourhet, L., and Martin, J. F.: A propos d'un cas de tumeur complexe du sein. (Conformations epitheliales glandulaires et sarcomateux.) *Considerations histo-pathologiques.* Lyons, *Chirurg.*, vol. xviii, p. 1425, 1921.
- Breucken, A. J., and Schleiter, H. C.: Lympho-sarcoma Involving Both Breasts. *Atlantic M.D.*, vol. xxix, p. 693, 1926.
- Brites, G.: Fibro-adenoma with Sarcomatous Evolution. *Case Folia Anat. Univ. Conimb.*, No. 6, vol. iv, p. 11, 1929.
- Caylor, H. H., and Shugrue, J. J.: Fibro-sarcoma of Male Breast. *M. Clin. N. Am.*, vol. x, p. 665, 1926.
- Chavannaz, and Nadal, P.: Epithelio-sarcome du sein. *Bull. de l' Assoc. franc. p. l'etude du cancer, Par.*, vol. xii, p. 144, 1923.
- Corey, and Thomas: Lipo-sarcoma of Mammary Gland of Dog. *Bull. de l' assoc. franc. l'etude du cancer*, vol. xvi, p. 143, 1926.
- Deaver, J. B., and McFarland, J.: *The Breast-Anomalies, Diseases and Treatment.* Blakiston, 1917.
- Denk, W.: Lesions of the Breast. *Wein. klin. Wchnschr.*, vol. xxxix, p. 1, 1926.
- Dyke, S. C.: Bony Tumor of Breast. *Brit. J. Surg.*, vol. xiv, p. 323, 1926.
- Elderman, H.: Osteoid Sarcoma; Case. *Beitr. z. Path. Anat. u.z. allg. Path.*, vol. lxxviii, p. 618, 1927.
- Elliott, J. D.: Tumor of the Breast. *S. Clin. N. Am.*, vol. vi, p. 161, 1926.
- Fisher, W.: Clinical and Pathologic-anatomical Diagnosis of Tumors and Cystic Processes in Mammary Gland. *Deutsche Ztschr. f. chir.*, vol. cxcii, p. 1, 1925.
- Flynn, L. C. W.: Sarcoma of Breast. *South. M. J.*, vol. xx, p. 191, 1926.
- Fowler, F. I.: Case of Osteochondroma of Female Breast with Review of Literature. *Northwest Med.*, vol. xxiii, p. 122, 1925.
- Fry, H. J. B.: Osteoclastoma (Myeloid Sarcoma) of Human Female Breast. *J. Path. and Bact.*, vol. xxx, p. 529, 1927.
- Fullerton, S.: Sarcoma Followed Twenty Years Later by Abdominal Carcinoma. *Lancet*, vol. i, p. 26, 1928.

- Geldmacher: Tumors of the Breast in the Male; Cases and Statistics. *Fortschr. d. Med.*, vol. xlv, p. 1426, 1926.
- Graves, T. C.: Mammary Sarcoma of Old Age. *Brit. M. J.*, vol. i, p. 81, 1920.
- Greenough, R. B., and Simmons, C. C.: Fibro-epithelial Tumors of the Mammary Gland. *ANNALS OF SURGERY*, vol. liv, p. 517, 1911.
- Hamann, C. A.: Sarcoma. *W. Virginia Med. J.*, vol. xxv, p. 413, 1929; also vol. xxv, p. 257, 1929.
- Helwig, F. C.: Carcinoma with Giant-cell Sarcoma; Report of Case. *Arch. Path. and Lab. Med.*, vol. iv, p. 162, 1927.
- Hewitt, H. W.: Breast Tumors: Their Diagnosis and Treatment. *J. Mich. M. Soc.*, vol. xxv, p. 179, 1926.
- Jessup, S. D.: A Case of Giant-cell Sarcoma of the Breast. *Proc. N. Y. Path. Soc.*, vol. xix, p. 117, 1919.
- Lee, J. B.: Sarcoma of Breast. *ANNALS OF SURGERY*, vol. lxxii, p. 387, 1920.
- Lenormant, C., and Moure, P.: Volumineux sarcome du sein *Presse med.*, Par., vol. xxxi, p. 513, 1923.
- Lifuendahl, R. A.: Lipo-sarcoma of the Mammary Gland. *Surg., Gynec., and Obstet.*, No. 50, vol. I, p. 81, 1930.
- McIver, M.: Teratoid Mixed Tumors of the Breast. *ANNALS OF SURGERY*, vol. lxxvii, p. 354, 1923.
- Mitterstiller, S.: Ein Fall von Mammasarkom beim Mann zur Frage des Nit Biermarkungen Myosarkoms. *Deutsche Ztschr. f. Chin.*, Leipz., vol. cxxxiv, p. 446, 1915.
- Murphy, J. B.: Scirrhus Sarcoma of Breast. *Surg. Clin.*, vol. v, p. 879, 1916.
- Norden, A.: Sarcoma of Mamma. *Nederlandsch. Trijdschr. V. Geneesh.*, vol. i, p. 3361, 1921; (ab. *J.A.M.A.*, vol. lxxvii, p. 980, 1921).
- Offergeld, H.: Bilateral Primary Sarcoma. *Arch. f. klin. chir.*, vol. cliii, p. 395, 1928.
- Peterson, A. J.: Sarcoma of Female Breast. *Tr. Chicago Path. Soc.*, vol. xii, p. 367, 1927.
- Porter, M. E.: Tumor of Breast. *Surg., Gyn., and Obstet.*, vol. xxxi, p. 584, 1920.
- Rohdenburg, G. L.: Sarcoma of the Breast; Report of Six Cases. *Proc. N. Y. Path. Soc.*, vol. xvii, p. 112, 1917.
- Seidemann, H.: Unusual Lympho-sarcoma. *Monat. Sebr. f. Gebrutsh. U. Glybak*, vol. lxxviii, p. 310, 1928.
- Silvan, C.: Fibro-epithelioma of the Mamma Degenerating into Sarcoma. *Gazz. d. Osp.*, vol. xl, p. 793, 1919.
- Sommerfeldt, T. A.: A Case of Sarcoma of the Breast. *Kristiania kir. for forth.*, pp. 128-132, 1916.
- Spaese, J.: Tumors of the Male Breast. *ANNALS OF SURGERY*, vol. lv, p. 530, 1912.
- Sutton: Sarcoma of Breast; Two Cases. *J. Mich. M. Soc.*, vol. xv, p. 190, 1926.
- Thinnes, H.: Chondro-sarcoma of Breast; cases. *Virchow's Arch. f. path. Anat.*, vol. cclxiv, p. 150, 1927.
- Thuer, W.: Sarcoma; Case. *Virchow's Arch. f. path. Anat.*, vol. cclxv, p. 96, 1927.
- Traina, L. S.: Carcino-sarcoma of Male Breast. *Tumori*, vol. xi, p. 35, 1924.
- Vaidya, J. B.: Three Interesting Cases of Malignant Disease. *Indian Med. Gaz.*, vol. lxii, p. 87, 1927.
- Wellbrock, W. L. A.: Sarcoma of the Breast with Foreign Body and Tumor Giant-cells. *ANNALS OF SURGERY*, vol. xc, p. 154, 1920.
- Westermarck, H.: Cysto-sarcoma of Breast. *Hygeia*, vol. lxxx, p. 352, 1918.
- Williams, W. R.: Varieties of Mammary Neoplasms and Their Relative Frequency. *Brit. Med. Journal*, vol. ii, p. 576, 1892.
- Winslow, R.: An Analysis of 102 Cases of Tumors of Breast. *ANNALS OF SURGERY*, vol. lxxiv, p. 341, 1921.
- Zonaquin, G.: Sarcoma of the Mamma. *Semana Med.*, vol. ii, p. 737, 1923.

## RETROPERITONEAL FIBROMYXOMA

By SAMUEL C. LIND, M.D.

OF CLEVELAND, O.

RETROPERITONEAL MYXOMA are very infrequent. In 1921, Von Wahlen-  
dorf<sup>1</sup> made careful search of the literature and tabulated 153 cases of retro-  
peritoneal lipomata. Of these, seventy, or 46 per cent., were pure lipomas,  
while eighty-three were mixed tumors, classified as follows:

- 31 of the 83, or 20 per cent., fibro lipomata
- 16 of the 83, or 10 per cent., myxolipomata
- 15 of the 83, or 10 per cent., fibromyxolipomata
- 21 of the 83, or 14 per cent., contained sarcoma tissue

Not a single case of myxoma unassociated with fat is recorded by Von  
Wahlendorf. A careful search of the recent literature has failed to uncover  
any report of retroperitoneal myxomata not associated with fat. Therefore,  
inasmuch as a careful examination of the tumor reported here revealed  
myxomatous and fibrous tissue only—no fat tissue was found—a record of  
the case may be of interest.

Mixed tumors of the retroperitoneal connective tissue present many  
unusual features. As Hosemann<sup>2</sup> remarks, "They are not so innocent as they  
appear." After an apparently complete removal, recurrences are frequent.  
The growth is often encapsulated and the operator believes that he has  
removed it in its entirety, but, none the less, there is a recurrence. Careful  
microscopic examination fails to uncover sarcomatous tissue, yet after one  
or more returns of the tumor, sarcomatous areas are found. Katz<sup>3</sup> believes  
that half of these growths reported as benign are malignant. Hosemann and  
Von Wahlendorf suggest that retroperitoneal lipomata are not single, but  
develop from several anlage. Minute growths are left behind after the  
removal of the primary tumor. These daughter growths are very small and  
are not seen at the operation. Later they develop and it is assumed that  
there is recurrence when, as a matter of fact, the unrecognized tumors have  
undergone rapid development.

The etiology of retroperitoneal mixed tumors is speculative. Of the vari-  
ous theories, that of congenital rests receives the greatest support. Other  
theories are: (1) mechanical irritation due to changes in nitro-abdominal  
pressure through the filling and the emptying of the bowel; (2) vasomotor  
disturbances; (3) disturbances in metabolism dependent upon the abuse of  
alcohol; (4) originating in the lymph-glands. Enlarged glands are frequently  
removed in the tumor mass, but, so far, no neoplastic tissue has been found  
in these glands. Just why lymph-glands enlarge without showing metas-  
tasis or inflammation is not clear. (5) The result of inflammatory processes.



Ewing,<sup>4</sup> Hertzler,<sup>5</sup> and Ribbert<sup>6</sup> are among those who support the congenital rest theory. Ewing theorizes that mucous tissue is widely distributed in the embryo especially in the subcutaneous tissue, and that myxoma arise from islands of such embryonic tissue. "Since such islands of mucous tissue may be readily associated with cartilage and fibrous and fat tissue, which are normally developed from the embryonal mesoblast, it is reasonable to explain the occurrence of many myxolipomas, fibromas, and chondromas by assuming their origin from islands of tissue which are partially differentiated, or which become so during the progress of the growth. It does not appear that pure myxomas ever tend to differentiate into fibroma or lipoma."

The few reported cases in children may tend to support the theory of embryonic origin. There are records of six cases occurring between the ages of one and six, and one instance in which the tumor was present at birth. Why congenital rests lie dormant for years, and what stimulus initiates their growth, is not known. Hertzler points out that this is the case with adrenal tumors. That trauma is an immediate stimulus is most improbable, and has been suggested only because certain more superficially located malignancies appear to their origin to trauma. I believe that the close relation of injury to the onset of various bone tumors is established. However, retroperitoneal myxomas are situated in regions seldom injured, and not subjected to prolonged irritation.

The site, age and sex incidence of retroperitoneal mixed tissue tumors is given by Von Wahrendorf as follows. In 148 cases we find:

	Women	Men
To 20 years	6	4
21 to 40 years	30	10
41 to 60 years	52	30
Over 60 years	13	4

It is interesting to note that the majority are found in women in a ratio of about four to one, and that two-thirds occur after the age of forty. The location of the tumors is given in 132 cases. Of these, 104 arose in the upper retroperitoneal space generally developing from the retroperitoneal fat. Twenty-eight were attached to the retroperitoneal tissue of the pelvis, while only fifteen originated in the true pelvis, from the fat in the hollow of the sacrum.

Retroperitoneal myxoma are remarkable in that they often attain a large size without causing the patient any considerable discomfort. The subject of this report had a growth as large as a child's head, weighing over 2900 grams, which gave rise to little distress. These tumors are among the largest found in man, and are known to have attained a weight of thirty to forty kilos. It is remarkable that life can exist in the presence of such huge growths. Many are discovered accidentally. The most constant complaint is a sense of weight, or heavy feeling in the abdomen. There is vague discomfort. Digestion may or may not be disturbed. Often this amounts to no more than belching gas after meals. The intestines may continue to

## RETROPERITONEAL FIBROMYXOMA

function in a normal manner until the tumor is very large indeed. Anæmia, loss of weight and loss of strength occur late in the disease, although, after a time, nutrition fails and the growth increases rapidly, and, as Well<sup>7</sup> remarks, "holds up protein and stores fat at the expense of the wasting body." Finally, pressure phenomena are noted. Impaired circulation in the abdominal veins, cava, iliacs, leads to œdema of the extremities, and dilatation of the veins of the abdominal wall. The free action of the diaphragm is hampered, with resulting dyspnœa. In certain instances, the kidneys are destroyed, and uræmia ensues. Again the ureters are constricted, hydronephrosis develops, and renal tissue is destroyed. Ascites is a late occurrence. Metastases take place late and in some cases have not been present.

The prognosis is bad. Keen's<sup>8</sup> Surgery states that the duration of life in unoperated cases is from two to three years after discovery of the growth, also that occasionally spontaneous cessation takes place after partial removal. This latter statement I am unable to confirm from other sources in the literature. Indeed, the authors are most emphatic in stressing the danger of recurrence after seemingly complete removal. The prognosis after operation should be most conservative. The immediate operation mortality, according to Von Wahlfendorf, is 14 per cent. in 113 operated cases, and tabulates sixty as cured. This latter statement is much too optimistic, and does not bear close scrutiny. Pritzi,<sup>9</sup> on the other hand, gives the operation mortality in patients operated upon since 1910 as being 7½ per cent. This improvement has been brought about by better surgical technic.

Retroperitoneal mixed tumors present great diagnostic difficulties. We must differentiate between ovarian cysts, uterine tumors, renal tumors, hypernephroma, cysts, hydronephrosis, pancreatic cysts, mesenteric cysts and tumors, and occasionally gall-bladder and wandering spleen. Incidentally, most patients have been operated upon under the diagnosis of one of the above-mentioned possibilities. Retroperitoneal myxomas are so rare that a surgeon is fortunate if he encounters three or four cases. Many operators with large practices have never seen a case. This lack of experience explains most of the failures to make the correct diagnosis. Schmid<sup>10</sup> reports forty-six collected cases operated upon under the diagnosis of ovarian cyst. He also says that with the abdomen open the diagnosis is not always easy.

When confronted with an abdominal tumor of uncertain origin, what can we do to aid us in reaching a diagnosis? History will aid in limiting the possibilities, and should be carefully taken. Retroperitoneal mixed tumors, as previously stated, occasion very little distress and frequently attain a large size before the physician is consulted. Loss of weight and anæmia are late manifestations. Therefore, it is unlikely that a malignant tumor, as ordinarily understood, could reach such proportions without causing more general disturbance. A history of menstrual irregularities would direct attention to the reproductive organs. Likewise, pyuria and hæmaturia point toward the kidney. Pancreatic cysts often are antedated by severe upper abdominal distress; likewise hydrops of the gall-bladder will usually be suggested by the

history. After the history has centered our attention on two or three possibilities and removed the rest of our immediate consideration, we proceed to the physical examination.

Retroperitoneal mixed tumors are fixed unless a portion of the growth has penetrated the leaves of the mesentery when mobility is marked. Their surface is smooth, although often lobules can be palpated. Pressure causes little or no pain. The consistency is semi-solid, and one often elicits a sense of fluctuation which leads to our erroneous diagnosis of ovarian cyst. The next diagnostic step is to determine the relation of the colon to the tumor. Retroperitoneal growths generally displace the colon toward the midline. This can be demonstrated with a barium enema and the X-ray. Pyelography is of great value in differentiating renal neoplasm and should be employed in reaching a diagnosis. Cholecystographs could be made if, as seems most unlikely, gall-bladder pathology should come into question in the differentiated diagnosis. Wandering spleens should be diagnosed through palpation and it seems unlikely that confusion should arise, Schmid says that a wandering spleen was the diagnosis when operation revealed a retroperitoneal mixed tumor. Evidently the diagnosis is one of elimination and at best will be uncertain. Perhaps if we determine that the tumor is retroperitoneal, and keep the possibility of myxoma in mind, we may be permitted to make a tentative diagnosis of retroperitoneal myxoma.

Having reached a probable diagnosis, what is the therapy? Unless the general condition of the patient is such as to forbid operation, removal should be attempted despite the chance of meeting with great difficulties. The operation may be relatively easy or attended with the greatest difficulty. R. Hofstalter and H. Schnitzler<sup>11</sup> report that out of fifty-six cases in which operation was undertaken, eleven were abandoned because of insurmountable technical difficulties. The kidney is often so involved in the growth that it must be sacrificed. Hence cystoscopic examination in cases presenting growths in the upper abdomen should be made without fail. It is a great comfort to the surgeon to know that the opposite kidney is competent. Again, the ureter may be accidentally severed. Intestinal resection may be required either because in removing the mass, the blood supply to a loop of bowels has been damaged, or because the intestinal wall has been lacerated. It is recorded that the vena cava has been torn, and, according to Von Wahllendorf, in several instances the operator has repaired the rent with happy outcome. In one instance the aorta was torn. One can readily understand how these accidents can happen. The huge growths make exposure difficult. They are in close relationship to these vital structures and by their very mass hinder the surgeon in obtaining clear exposure. It is unfortunate that the patients suffer so little discomfort that they do not consult a physician until the tumor has reached a large size. Unquestionably the earlier the operation the better is the prognosis, both immediate and late. Infection, which caused so many deaths in earlier times, is no longer so great a hazard. Better anaesthesia further reduces the risk of operation.

## RETROPERITONEAL FIBROMYXOMA

Methods of combating shock, which was responsible for a number of deaths in the earlier operations, will save patients who some years ago would have succumbed. Therefore, if the patient's condition is reasonably good, we should recommend operation, knowing that surgery offers the one chance.

Röntgen-rays have been tried, both pre- and post-operative, and no one claims that they have been of value. Perhaps they should be used after the patient has recovered from the operation. R. Hofstalter and H. Schnitzler report a treatment several months with X-rays before operation was done, but without the least benefit resulting. The tumor continued to increase in size.

Mrs. E. J., aged thirty-nine, consulted her physician in March, 1930, on account of a tumor of the lower abdomen. She first noticed this mass in January, 1930, at which time the upper limit was just above the symphysis. The tumor, in spite of a rapid growth during the next two months, occasioned very little discomfort. There was increased urinary frequency, which appeared to have begun in November, 1929. However, following the birth of her first child seven years ago, the patient had had more or less bladder irritability and she was not disturbed when this symptom became a little more pronounced. She experienced a vague sense of discomfort in the abdomen, and at times noticed a few short, cramplike pains in the lower abdomen. These pains came soon after eating, but did not last long. Her bowels acted without cathartics and her general health continued good. Both the patient and her husband were positive that her weight had increased during the past six weeks, and her acquaintances had remarked upon her healthy appearance.

In October, 1929, her menstrual period lasted but one day, and a physician, consulted at this time, suggested the possibility of pregnancy, but unfortunately did not make an examination. The patient was certain that no abdominal tumor was present, so we may assume that the growth had not attained a size large enough for the patient to find. The menses in December, January, and February were not remarkable.

The past history had no bearing on the present illness. The patient has always enjoyed good health, and denied any serious illnesses. There was no history of miscarriages nor operations or serious injuries. Her husband and two children, three and seven years of age, are all in good health. Her confinements were uncomplicated, spontaneous delivery and normal puerperium. However, as noted above, since the birth of the first child, there has been more or less bladder irritability.

The family history disclosed the following facts: Father died—seventy years—cause unknown. Mother died—sixty years—carcinoma of stomach. Two brothers are living and well. No sisters.

The patient is a well-developed, well-nourished woman, five feet, six inches tall, weighing 160 pounds. The mucous membranes are of good color and do not suggest anæmia. The lower abdomen is symmetrically distended. Palpation reveals that this distention is due to a rounded tumor, which extends to the umbilicus. This mass pretty well fills the lower abdomen, is fixed, semi-solid, smooth, and irregular enough to suggest lobulation. Palpation is painless except at the upper mid-portion of the tumor, where pressure elicited a little tenderness. At operation, this portion was seen to be the site of an old hæmorrhage. Omentum and ilium were adherent at this point, and this probably explains the tenderness.

Vaginal examination showed a perineal tear of grade 1. The cervix was slightly irregular, pushed up under the symphysis, and of average firmness. The fundus uteri could not be found. The entire pelvis was filled with a fixed semi-solid tumor mass, extending to the umbilicus. The adnexa were not made out. On bimanual examination, there was a suggestion of fluctuation. One got the impression that the tumor might



contain fluid under considerable tension. Certainly the mass was softer than one would expect a fibroid to be. The rest of the physical examination showed no further pathology. No free fluid was found in the abdomen. The liver and spleen were not enlarged. Heart and lungs were normal. No glandular enlargements were found. The laboratory reported that the urine was free from abnormal constituents, that the red count was 4,900,000, hæmoglobin 95 per cent. Talquist and the white count 8,200.

Exploratory operation was advised and accepted. On March 14, 1930, under ether-gas anæsthesia, the abdomen was opened through a long left rectus incision. A smooth, glistening, white-yellow mass was seen filling the pelvis. No free fluid was noted. The omentum was adherent to the upper posterior surface of the growth to the distance of almost four inches; this was ligated. Then a loop of ilium was dissected free, the intestines were packed away and an attempt made to deliver the tumor. This was impossible. The uterus was next located, with some difficulty, in front of the mass, pressed tightly against the symphysis pubis. The ovaries and tubes were identified, and it was seen that the tumor was not connected with these structures, but that it had its origin in the hollow of the sacrum. The peritoneum was incised transversely in front of the mass as low down as possible, a plain of cleavage found, and we were able to enucleate the mass intact, except at its very base. The removal was surprisingly easy. The vessels were secured, and a pack placed in the hollow of the sacrum to control oozing. The right ureter was bared for a matter of two inches, and appeared to be a little increased in diameter, but otherwise not remarkable. A strip of gauze protected with rubber dam was placed against the denuded hollow of the sacrum to control the oozing from a number of very small vessels. The patient left the table at the end of fifty minutes, and proceeded to make an uneventful recovery. The total amount of blood lost was very moderate. The main vessels came from the side of the pelvis, and were caught with the peritoneum, as it was cut around the base of the tumor. They were disproportionately small in comparison with the size of the mass—strikingly so. The greatest difficulty in the technic was in getting exposure.

The tumor was encapsulated, and weighed 2,900 grams. One tubule on the superior anterior surface showed dark discoloration from hæmorrhage, and this lay directly beneath the tender area of the abdominal wall. On section, the tumor was composed of a number of lobules, varying in size from that of an English walnut to that of an egg. They were silver-white in color, smooth, soft and loosely joined together with connecting tissue. Individual lobules could be easily removed and peeled out from the growth. Indeed, the tumor resembled a sac of many small tumors, lightly adherent one to the other. Later a mucoid sticky fluid began oozing from the cut surface. No cysts were found, as have been reported as occurring in retroperitoneal mixed tumors. There were a few firm areas, which the microscopic examination showed were made up of fibromatous tissue.

Dr. A. R. Moritz reports as follows:

The specimen (Fig. 1) consists of an encapsulated, irregularly lobulated, firm, translucent mass of tissue weighing 2,900 grams after formalin fixation. Several portions of the tumor had been separated from the whole so that it is not possible to establish the continuity of the capsule. Where the tumor is intact, however, the capsule appears thin, smooth, and shows no evidence of invasion. The density of the tumor varies, being in places quite solid and in places almost of cystic consistency. The more solid areas are the more opaque and many small blood-vessels can be seen at a considerable depth beneath the surface. Only in one place can any blood-vessels be seen to enter the tumor and these are not invaded by tumor tissue. Adherent to the outer surface of the tumor are some small lobules of adipose tissue having the appearance of omentum.

On section a large amount of tenacious mucoid material exudes from the cut surface. This material was clear and transparent. The areas of greatest density were relatively dry, appeared fleshy in contrast to the acellular mucoid areas and were covered by thicker capsule than seen generally. Although the vascularization of the tumor was



## RETROPERITONEAL FIBROMYXOMA

prominent because of its translucency, the surface did not bleed and the general impression was gained that the tissue was quite avascular.

*Histological examination.*—A number of sections were taken, including both central and peripheral portions of the tumor and cellular and acellular areas, characteristic of



FIG. 1.—Retroperitoneal Fibrolepoma.

the specimen were the sections taken from the relatively acellular translucent areas and they were comprised chiefly of a finely fibrillar, slightly basophilic matrix distributed throughout which were uniform, stellate outlined cells having multiple irregular cytoplasmic processes which appeared to anastomose one with another. It was in the



FIG. 2.—Fibromyxoma. Magnification  $\times 120$ .

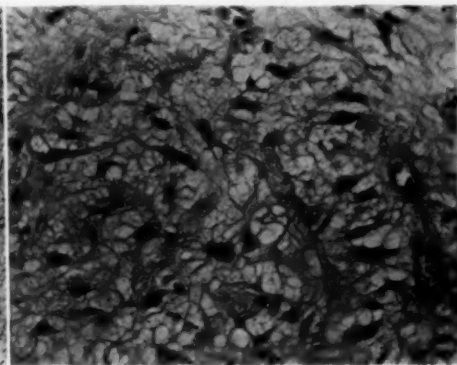


FIG. 3.—Fibromyxoma. Magnification  $\times 600$ .

interstices between these processes that the basophilic material was deposited. The cytoplasm of these cells was acidophilic. The nuclei varied in size and shape, were hyperchromatic and were relatively small. Supporting the tumor were fairly regularly disposed fibrous trabeculae carrying thin-walled blood-vessels and these trabeculae appeared to be formed by condensation of the cells constituting the tumor. Scattered throughout the tissue were large, round, endothelial cells.

Other areas of tumor showed variations from this picture which were relative. In some areas the cells were thickly disposed, showed more nuclear irregularity and the cytoplasm was in some instances confluent to suggest syncytial cell masses. Along with the variation in size and shape of nuclei there were occasional but infrequent mitoses. There was no evidence of blood vascular invasion. Other portions of the tumor showed an acidophilic rather than a basophilic matrix, this matrix having the appearance of hyaline.

The inner structure of the tumor is shown, after dividing the mass into two parts. Various sized lobules are seen, while under and below the rule there is a portion of the resected omentum, which was adherent to the growth. Portions of the capsule are seen.

This report has been prompted by the fact that a reasonably careful search of the literature has failed to reveal a single case of pure retroperitoneal fibromyxoma. All cases reported were mixed lipomas. We are satisfied that this tumor does not contain any areas of lipoma tissue; that a sarcomatous area has been overlooked is probable. We hope that calling the attention of the profession to retroperitoneal mixed tissue growths will make us think of this possibility when next confronted with an abdominal tumor of uncertain etiology. It is to be noted that the growth was cut in half before a picture was made. Thoughtless interest to see the inside of the tumor led us to lay it open immediately after removal. Encapsulation was complete except at the point of origin in the hollow of the sacrum. The infrequent occurrence of these tumors, their difficulty of diagnosis, their unusual features of rapid growth tending to recur after apparently complete removal and the operative hazards, warrant placing this case on record.

#### REFERENCES

- <sup>1</sup> Von Wahleldorf, Adolph Ritter Liebermann: *Über retroperitoneal Lipoma*. Arch. F. Klin. Chirug., vol. clvi, p. 751, 1921.
- <sup>2</sup> Hosemann, G.: *Über das rezidivierende retroperitoneal Lipoma*. Arch. F. Klin. Chirug., vol. cxv, p. 336, April, 1929.
- <sup>3</sup> Katz: *Über retroperitoneal Lipoma*. Bitz Klin. Chirug., vol. cxiv, p. 864, 1928.
- <sup>4</sup> Ewing: *Neoplastic Diseases*. Third Edition, p. 183, Saunders, 1928.
- <sup>5</sup> Hertzler: *The Peritoneum*, vol. ii, p. 784.
- <sup>6</sup> Ribbert: *Frankfurter Zisch. F. Path.*, vol. iv, p. 30, 1910.
- <sup>7</sup> Wells, H. G.: *The Fat Metabolism of Lipomas*. Arch. Int. Med., vol. x, p. 297, 1912.
- <sup>8</sup> Keen's *Surgery*, vol. 3, p. 757.
- <sup>9</sup> Pritzi, Otto: *Zwei Falle Von Retroperitoneal Geschwulstern*. Arch. F. Klin. Chirug., vol. cxl, p. 583, 1926.
- <sup>10</sup> Schmid, H. H. F.: *Gynak.*, vol. cxviii, p. 490, 1921.
- <sup>11</sup> Hofstalter, R., and Schnitzler, H.: *Arch. F. Klin. Chirug.*, vol. cxl, p. 567, 1926.

# TETANUS IN NEW ORLEANS

AN ANALYSIS OF 813 CASES

By AMOS MAVERICK GRAVES, M.D.

OF NEW ORLEANS, LA.

FROM THE DEPARTMENT OF SURGERY, SCHOOL OF MEDICINE OF TULANE UNIVERSITY, AND THE CHARITY HOSPITAL

It is the purpose of this paper merely to emphasize certain important points and record statistical data on 813 cases of tetanus which have been admitted to the various surgical services of the Charity Hospital of Louisiana, at New Orleans, from 1906 to 1930. Gessner,<sup>6</sup> in 1918, reviewed 368 of these cases, and in 1923 Graffagnino<sup>7</sup> reported 596 cases, which included those previously presented by Gessner.<sup>6</sup> Since 1923 there have been 217 additional cases admitted to the Charity Hospital, making a total of 813 cases for consideration.

*Sites of wounds.*—In comparing the mortality rates (Table I) for tetanus developing from various wound sites, it will be noted that those of the upper extremities were attended with a mortality rate of 67.6 per cent. and those of the lower extremities by a mortality rate of 55 per cent. This is as would be expected, but in contradistinction to other reported series the mortality rate for five cases following wounds about the head and face was only 40 per cent., and for four cases due to infected teeth it was only 25 per cent.

TABLE I  
*Sites of Wounds*

Site of wound	Graffagnino's series	New series	Mortality per cent new series
Lower extremities.....	352	111	55
Upper extremities.....	83	37	67.6
Head and face.....	32	5	40
Teeth.....	1	4	25
Back.....	9	..	..

*Types of injuries.*—In fifty-two cases of tetanus which developed from a nail puncture wound the mortality rate was 67.3 per cent., whereas in fifty cases in which the wound was produced by a splinter, it was only 46 per cent. In seven cases of tetanus neonatorum, in two cases of tetanus occurring postpartum, in three occurring in morphine addicts, and in six in patients who had had criminal abortions, the mortality rate was 100 per cent. (Table II).

Blank cartridge wounds deserve special comment. There were twenty-four cases of tetanus due to such wounds, and the mortality rate in these was 83.3 per cent. Certainly such a high incidence of tetanus and high mortality rate are sufficient arguments for the abolition of such a dangerous and needless method of celebrating Christmas week and Independence Day.

It is probably not generally appreciated that the wool wadding used in blank cartridges is nearly always contaminated with tetanus spores or bacilli,

# AMOS MAVERICK GRAVES

TABLE II  
*Types of Injuries*

Type of injury	Graffagnino's series	New series	Mortality per cent. new series
Splinter.....	163	50	46
Nail.....	122	52	67.3
Incised wound.....	44	..	..
Crushed wound.....	42	..	..
Brush burns.....	38	..	..
Tetanus neonatorum.....	36	7	100
Punctured wounds (excluding nails).....	16	2	50
Firecrackers, blank cartridges, and airgun.....	23	..	..
Blank cartridges.....	..	24	83.3
Abortions.....	15	6	100
Postpartal.....	..	2	100
Morphine addicts.....	9	3	100
Compound fractures.....	..	2	50
Ulcer.....	3	1	100
Gangrene of toe.....	..	1	100
Amputation of stump.....	..	1	100
Cancer of breast—post-operative.....	..	1	100
Furuncle.....	1	..	..
Vaccination.....	1	..	..
Extraction of teeth.....	..	3	33.3
Gunshot wounds.....	6	3	100

as is most woolen clothing through which so many injuries are sustained. In treating wounds one is prone to associate with tetanus only those which are received in the garden or stable. There is no doubt that many clean foreign bodies carry with them tetanus spores from woolen clothing, which they penetrate to inflict an injury. Wounds received in such a manner at least deserve a débridement.

*Incidence by months.*—The incidence of tetanus by months in this series (Table III) is in accordance with other series in that tetanus appears to be a disease of the open season. The highest incidence was for the summer months with almost as many cases occurring in December and January. The high incidence for these two winter months is explained by the fact that in New Orleans many gunshot and blank cartridge wounds are received from Christmas Day to and through New Year's Day.

An interesting observation in this study concerning incidence of tetanus by months as shown in Table III is that for the twenty-three cases admitted in September the mortality rate was only 8.7 per cent., whereas in other months it was many times higher. There is no apparent explanation of this.

*Incubation period compared with mortality rate.*—In this series the lowest mortality rates occurred in those cases in which the incubation period was from ten to twenty-one days. The increase in mortality rate as shown in Chart I for cases with incubation periods of over three weeks is probably due to the presence of foreign bodies and suppuration in the wounds.

*Prophylaxis and the incidence of tetanus.*—Eight cases in the present

# TETANUS IN NEW ORLEANS

series (Chart I) had received one prophylactic dose of antitetanic serum. In only three of these was the incubation period of more than three weeks, being

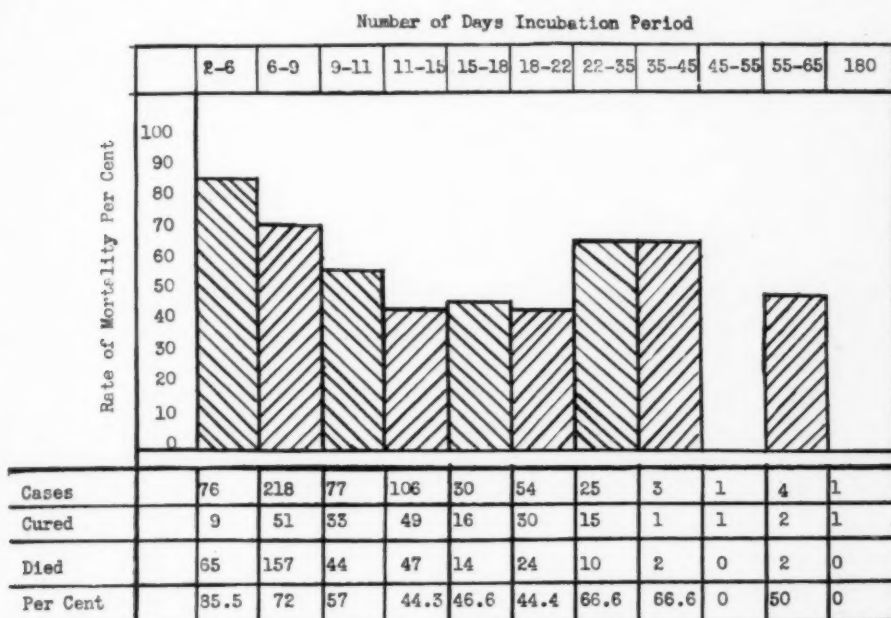


CHART I.—Incubation periods with mortality rate.

twenty-eight, sixty and sixty days, respectively. Four of these eight cases died.

That a prophylactic dose of antitetanic serum will frequently prevent the development of tetanus was conclusively established in the Great War. In

TABLE III

*Incidence of Tetanus by Months with Mortality Rate*

Months	Cases	Discharged	Died	Mortality per cent.
January.....	27	6	21	77.7
February.....	7	5	2	28.5
March.....	19	7	10	52.6
April.....	13	6	7	54
May.....	15	5	10	66.6
June.....	21	8	13	62
July.....	17	10	7	41
August.....	27	10	17	63
September.....	23	21	2	8.7
October.....	22	10	12	54
November.....	7	4	3	43
December.....	16	4	12	75

the United States army, 1,500 units of antitetanic serum were given routinely to all wounded, and this dose was repeated after seven days whenever there was the slightest indication. Such prophylaxis,<sup>3</sup> in combination with proper



# AMOS MAVERICK GRAVES

care of the wounds, kept the incidence of tetanus down to thirty-six cases in 224,089 wounded soldiers, or one case for each 6,224 wounded. In the Civil War, Sanford<sup>8</sup> states that there was one case of tetanus for each 487 wounded, or 505 cases in 246,172 wounded.

Sir David Bruce<sup>9</sup> reports that in 2,032,142 wounded British soldiers tetanus developed in 2,385 or in 1.17 per thousand. In October, 1914, the incidence was thirty-two for each 1,000 wounded, but in November, when the administration of antitetanic serum was begun, the incidence immediately dropped to about two per thousand and remained so throughout the war.

*Prophylaxis and the incubation period.*—That the administration of one prophylactic dose of antitetanic serum will greatly prolong the incubation period in those cases destined to develop tetanus is improbable. The anti-toxin remains in the blood-stream approximately eight days and is then rapidly and completely excreted by about the tenth day. It is, therefore, reasonable to assume that such a prophylactic dose can only prolong the incu-

TABLE IV  
Mortality Rate by Years

Period	Cases	Discharged	Died	Mortality per cent.
1840-49 (Incomplete) . . . . .	16	5	11	68.7
1850-59 . . . . .	87	17	70	80.4
1860-69 . . . . .	57	14	43	75.4
1870-79 . . . . .	75	17	58	77.3
1880-89 . . . . .	81	13	68	83.9
1890-99 . . . . .	150	33	117	78
1900-05 . . . . .	101	35	66	65.3
1906-09 . . . . .	72	19	53	73.6
1910 . . . . .	33	7	26	78.8
1911 . . . . .	28	9	19	67.9
1912 . . . . .	33	8	25	75.8
1913 . . . . .	44	11	33	75
1914 . . . . .	51	15	36	70
1915 . . . . .	61	22	39	63.9
1916 . . . . .	33	13	20	60
1917 . . . . .	48	16	32	66.6
1918 . . . . .	17	7	10	58.8
1919 . . . . .	38	14	24	61.2
1920 . . . . .	44	10	34	77.3
1921 . . . . .	46	21	25	54.3
1922 . . . . .	48	19	29	60
1923 . . . . .	39	15	24	61.5
1924 . . . . .	37	13	28	75.7
1925 . . . . .	25	13	12	48
1926 . . . . .	31	24	7	22.5
1927 . . . . .	32	13	19	59.3
1928 . . . . .	29	12	17	58.6
1929 . . . . .	24	13	11	45.8
<hr/>				
1840-1905 . . . . .	567	134	433	76.4
1906-1922 . . . . .	577	188	389	67.4
1923-1929 . . . . .	217	103	114	52

# TETANUS IN NEW ORLEANS

bation period for the short period that it is in the blood-stream. For this reason, the antitetanic serum should always be repeated on about the seventh day whenever a wound is a favorable one for the development of tetanus. That one prophylactic dose of serum does not greatly influence the length of the incubation period is substantiated by the fact that in 343 cases which occurred in British soldiers in France the average incubation period was, according to Cummins and Gibson,<sup>10</sup> 13.2 days. In the British "home hospitals," where prophylaxis was adequately repeated and where there was the influence of other factors, the average<sup>11</sup> incubation period was 45.5 days.

*Prophylaxis and mortality rate.*—That the prophylactic use of antitetanic serum lowers the mortality rate in those who develop tetanus is well established, but it is probably not generally appreciated that the proper care of the wound in which tetanus is apt to develop is more important than the administration of serum. Serum protects the individual for only a week, whereas proper and adequate care of the wound removes all possibility of the development of the infection. Many reports of cases with long incubation periods substantiate this. Débridement should be performed on all wounds in which there is a possible contamination with tetanus bacilli, and in most cases the wound should be left wide open and drainage not hindered by the application of a tight bandage.

When one compares the mortality rate of 67.4 per cent. from 1906 through 1922 with the rate of 52 per cent. from 1923 through 1929 and considers that in the former period half the cases received no antitetanic serum at all and that only eight patients were given over 50,000 units, it would seem that more adequate serum therapy in the latter period is responsible for the decrease in mortality rate. This decrease in the mortality rate is largely due to the disproportionate decrease in the number of deaths occurring in children under thirteen years of age. (Tables V and VI.)

TABLE V  
*Mortality Rate by Years in Children Under Thirteen Years*

Period	Cases	Discharged	Died	Mortality per cent.	Cases omitted
1906-22.....	310	106	204	65.8	10 questionable
1923.....	17	5	12	70.5	
1924.....	20	12	8	40.0	
1925.....	15	11	4	26.6	
1926.....	21	17	4	19.0	1 tetanus neonatorum
1927.....	13	7	6	46.1	3 tetanus neonatorum
1928.....	14	7	7	50.0	
1929.....	13	7	6	46.1	2 tetanus neonatorum
1923-1929.....	113	66	47	41.5	

Tables V and VI demonstrate that the mortality rate in adults from 1906 to 1922, inclusive, was 70 per cent. or only 4.2 per cent. higher than it was in children for the same period. In this series the average dose of

# AMOS MAVERICK GRAVES

TABLE VI

*Mortality Rate by Years in Adults*

Period	Cases	Discharged	Died	Mortality per cent.	Cases omitted
1906-1922.....	286	84	202	70.0	
1923.....	22	10	12	54.5	3 died within 8 hrs.
1924.....	17	1	16	94.1	1 died within 8 hrs.
1925.....	10	2	8	80.0	1 died within 8 hrs.
1926.....	10	7	3	30.0	3 died within 8 hrs.
1927.....	19	6	13	68.4	1 died within 8 hrs.
1928.....	15	5	10	66.6	
1929.....	11	6	5	45.4	
1923-29.....	104	37	67	64.4	

antitetanic serum administered was about 13,000 units per patient given serum therapy.

*Antitetanic serum therapy.*—Since 1923, moderately large doses of serum have been used, and the mortality rate in children has decreased from 65.8 per cent. to 41.5 per cent., whereas in the adults it has merely dropped from 70 per cent. to 64.4 per cent. The children actually received relatively larger average total doses (48,000 units) of antitetanic serum for their body weight than did the adults (average 52,400). This fact might suggest itself as the cause for the greater lowering of the mortality rate in children, but it should be recalled that the dose should not be estimated on the size of the patient, but on the amount of toxin which is thought to be in the blood-stream. In contrasting such large series as these, it is fair to assume that the virulence of foci of tetanus infections averaged about the same.

Table VII is reproduced from Graffagnino's 1906-1923 series to show in 577 cases the effects of various doses of antitetanic serum compared with those obtained without the use of serum. In this series the mortality rate for

TABLE VII

*Dosage and Mortality Rate in Graffagnino's Series*

Dose of serum	Cases	Discharged	Died	Mortality per cent.
501-1,000 units.....	4	1	3	75
1,001-10,000 units.....	202	68	134	66.3
10,001-20,000 units.....	32	9	23	71.8
20,001-50,000 units.....	27	10	17	63.0
50,001-100,000 units.....	6	2	4	66.6
Over 100,000 units.....	2	1	1	50.0
No serum used.....	304	97	207	68.0
Serum used.....	273	91	182	66.6
Average dosage 13,000 units				

the 304 cases which did not receive antitetanic serum was 68 per cent., whereas in the 273 cases treated with serum it was 66.6 per cent. or only 1.4 per cent. lower in those who received serum therapy. As it is evident

# TETANUS IN NEW ORLEANS

that small doses (average 13,000 units per patient) of serum were given, a marked change in the mortality rate could hardly be expected. If it is assumed that in many instances serum therapy was given to the more severe cases, there would be less reason to expect a lowering of the mortality rate.

The mortality rates since 1923 for children on various dosages of serum are shown in Table VIII. The larger doses have not produced an unusually low mortality rate except in the eight cases which were given 90,000 to 120,000 units of antitetanic serum. All of these recovered, but this is of no great significance because of the small number of cases. In this recent series of children the average dose of antitetanic serum was 48,000 units per patient, whereas in Graffagnino's series the average was 13,000 units. In the recent series, the mortality rate was 41.5 per cent. in contrast to 65.8 per cent. in Graffagnino's series. This would seem to indicate that larger doses of antitetanic serum are distinctly of value in children.

TABLE VIII

*Mortality Rates of Various Doses of Serum for Children Only from 1923 through 1929*

Units of serum	Cases	Discharged	Died	Mortality per cent.
500-19,999.....	11	6	5	45
20,000-39,999.....	27	13	4	51.5
40,000-49,999.....	24	18	6	25.0
50,000-59,999.....	11	7	4	36.6
60,000-89,999.....	26	13	13	50.0
90,000-119,999.....	8	8	0	0.0
120,000-155,000.....	3	1	2	66.0
180,000.....	1	1	0	0.0
No serum used.....	3	0	3	100.0
	114	66	47	41.5

Average dose of serum used: 48,000 units per patient.

Examination of the hospital records reveals that in many cases 40,000 units of antitetanic serum were administered to children on admission. It is not improbable that many of the moderately severe cases improved after the administration of this dose and were, therefore, given no more serum, whereas many of the more severe cases which did not improve were given additional small doses at a time when it was too late to be effective, thus increasing the mortality rate for those receiving larger total doses. Twenty-four children were given from 40,000 to 50,000 units of antitetanic serum and of this number only six, or 25 per cent., died. Because of this favorable mortality rate, one might conclude that an initial dose of 40,000 units is probably adequate for a child who has developed a moderately severe case of tetanus after a long incubation period. But the more severe cases which develop after a short incubation period certainly should receive much larger initial doses of serum and serum therapy should be continued until there is marked symptomatic improvement.

# AMOS MAVERICK GRAVES

A comparison of the adult mortality rates in this series for various dosages of antitetanic serum (Table IX) makes it evident that the amount of antitetanic serum given made little or no difference except in the nine cases receiving 120,000 or more units in which the mortality rate was only 33.3 per cent.

TABLE IX  
*Adult Mortality Rates and Serum Dosage*

Dosage of serum	Cases	Discharged	Died	Mortality per cent.
10,000-19,999.....	6	1	5	83.0
20,000-39,999.....	23	7	16	70.0
40,000-59,999.....	17	10	7	41.0
60,000-89,999.....	25	6	19	76.0
90,000-119,999.....	11	3	8	72.0
120,000-149,999.....	6	3	3	50.0
203,000-240,000.....	3	3	0	0.0
No serum 1922-29.....	13	3	10	77.0
With serum 1922-29.....	104	37	67	64.4
With serum 1906-22.....	273	91	182	66.6
Average dosage.....	13,000			
No serum 1906-22.....	304	97	207	68.0

Average dosage: 52,400 units.

Comparison of the mortality rates of 68 per cent. for 304 adult cases which received no serum from 1906 to 1922, with that of 64.4 per cent. for 273 adult cases which received moderately large total doses of antitetanic serum (average 524,000 units per patient) suggests that serum therapy is of little or no value. But when it is recalled that the child mortality rate dropped from 65.8 per cent. to 41.5 per cent. when moderately large doses of antitetanic serum were given, it would seem that it is not the serum at fault but probably the amount given.

Examination of the hospital records suggests that frequently the initial dose of antitetanic serum given was not large enough and in many cases it was evident that the administration of serum was not repeated at all, not often enough or not soon enough.

That antitetanic serum used therapeutically greatly lowers the mortality rate in tetanus has never been conclusively proven. However, most surgeons are afraid not to use it and favorable enough statistics have been accumulated to justify its use.

Poland<sup>12</sup> found in the "pre-serum" days a mortality rate of 84.2 per cent. in sixty-three cases at Guy's. In 1870-71 the German military mortality rate was 90 per cent. in 350 cases.

Wainwright<sup>4</sup> reviewed the literature and found a mortality rate of 64 per cent. in 537 cases not treated with antitetanic serum as compared with 41 per cent. in 806 cases treated with serum.

Miller<sup>8</sup> reports that ninety-six cases of tetanus were admitted to the Massachusetts General Hospital since 1806. In these the mortality rate was 67.7 per cent., whereas in the twenty-five cases admitted since 1916 the mortality rate was 52 per cent. From



## TETANUS IN NEW ORLEANS

his five case reports it is apparent that his cases received 100,000 or more units of antitetanic serum intravenously and intraspinally.

Freeland<sup>2</sup> reports a mortality rate of 36 per cent. in twenty-five consecutive cases treated with massive doses of antitetanic serum given intravenously. He suggests that the average case should be given 315,000 units.

Ashhurst<sup>1</sup> reports a mortality rate of 38.8 per cent. in eighteen cases treated with moderately large doses of antitetanic serum given intraspinally in combination with other routes.

Stone<sup>3</sup> reports a mortality of 53 per cent. in forty-nine cases admitted to Los Angeles County Hospital. He advocates a total average of 125,000 units of antitetanic serum per patient to be given intraspinally and intravenously. He records a mortality rate of 35.6 per cent. for fourteen cases which received from 60,000 to 350,000 units of antitetanic serum.

*Routes of administration of serum.*—It is regretted that this series offers no information of value as to the best route for administration of antitetanic serum. In all cases, serum was given by the combined intravenous and intramuscular routes. In many it was given subcutaneously as well. In only thirteen was it given intraspinally and in these it was given in combination with other routes. The mortality rate in these thirteen cases was 46 per cent.

The intraspinal administration of antitetanic serum combined with other routes has been attended with good results in the small series of Ashhurst,<sup>1</sup> Stone,<sup>3</sup> and Miller,<sup>5</sup> but results from its use in larger series are less favorable.

Cummins and Gibson,<sup>10</sup> in reporting statistics on British army patients with tetanus in France, found a mortality rate of 68.2 per cent. for 360 cases treated intrathecally alone or in combination with other routes as compared with 64.5 per cent. for 164 cases not treated intrathecally.

Bruce,<sup>9</sup> in a report on tetanus infection which occurred in British "home hospitals," found a mortality rate of 32.9 per cent. for 804 cases treated intrathecally alone or in combination with other routes as compared with 20.8 per cent. for 585 not treated intrathecally.

Wainwright,<sup>4</sup> in an analysis of cases collected by questionnaire, found a mortality rate of 61.7 per cent. for 243 cases treated intrathecally alone or in combination with other routes as compared with 52.2 per cent. for 297 not treated intrathecally.

### SUMMARY

A total of 813 cases of tetanus are reviewed with a more detailed study of the 217 cases which recently have been admitted to the Charity Hospital of Louisiana.

In this series it is found that tetanus developed more frequently from wounds of the lower extremities than from wounds of the upper extremities, but that the mortality rate was 12.6 per cent. higher in the latter group.

Of the common wounds the highest incidence occurred in nail puncture wounds which were attended by a mortality rate of 67.3 per cent. This mortality rate was only 16 per cent. lower than that which occurred in twenty-four cases of tetanus which developed from blank cartridge wounds. In seven cases of tetanus neonatorum and the few cases developing post-partum, in morphine addicts, and after abortions, the mortality rate was 100 per cent.

More cases of tetanus occurred in the summer than in the spring and fall, but in contradistinction to other reported series the months of December and January had a high incidence due to the many gunshot and blank cartridge wounds which were received during the Christmas holidays. For no apparent reason twenty-three cases admitted in September had a mortality rate of only 8.2 per cent.

The greatest number of cases of tetanus developed after incubation periods of from six to fifteen days, and the lowest mortality rate occurred in those cases developing after incubation periods of from ten to twenty-one days. Four deaths occurred in eight cases which had received prophylactic doses of antitetanus serum.

The importance of repeating the prophylactic dose of antitetanic serum every seven days is emphasized as it has been found that antitetanic serum protects the patient likely to develop tetanus only for the eight to ten days that it remains in the blood-stream.

The Charity Hospital mortality rates in tetanus by years are shown not to have varied markedly from 1840 to 1922. From 1840 to 1905, when antitetanic serum was administered to only a few cases, the mortality rate was 76.4 per cent., whereas in 577 cases admitted from 1906 to 1922, inclusive, it was 67.4 per cent. Of this latter group only 273 patients were given antitetanic serum (average dose 13,000 units). From 1923 to 1929, the mortality rate decreased to 52 per cent. for 217 patients who were given moderately large doses of antitetanic serum (average dose 50,000 units). This decrease in mortality rate for the latter group is occasioned by a disproportionate decrease in the mortality rate in children.

From 1906 to 1922, inclusive, the mortality rate in 310 cases of tetanus which occurred in children under thirteen years of age was 65.8 per cent., or only 4.2 per cent. lower than for 286 adults during the same period. But from 1923 to 1929, inclusive, the child mortality rate in 113 cases was 41.5 per cent., whereas in 104 cases in adults it was 64.4 per cent. The average amount of antitetanic serum administered to adults was 52,400 and to children 48,000 units. These dosages at first seem disproportionate, but it is not the size of the patient but the amount of toxin in the blood-stream which should determine the dose.

Considering this marked decrease in the child mortality rate since moderately large doses of antitetanic serum have been used, it is apparent that adequate antitetanic serum therapy is of distinct value in the treatment of tetanus in children. Because there were only six deaths in the twenty-four cases in children which were given total doses of 40,000 to 60,000 units of serum, it seems that an initial dose of 40,000 units of serum should be adequate for the cure of many of the moderately severe cases in children.

In the adult cases the mortality rate was not greatly influenced by any particular amount of antitetanic serum administered, although the rate was only 33.3 per cent. for the nine cases which received more than 119,000 units of serum.

## TETANUS IN NEW ORLEANS

All cases in the recent series received antitetanic serum by the combined intramuscular and intravenous routes. Not infrequently the subcutaneous route was used in addition. The intraspinal route alone was not used in any case, but it was combined with other routes in thirteen cases, of which six died.

### CONCLUSIONS

Wounds of the lower extremities cause more cases of tetanus than those of the other parts of the body, but the mortality rate is lowest in the cases developing from wounds of the lower extremities.

Of all common wounds in which tetanus developed those produced by nails were attended with the highest mortality rate.

Because of the many blank cartridge wounds resulting in tetanus with an associated mortality rate of 83.3 per cent. in this series, it is thought that such a needless and dangerous method of celebrating should be abolished.

Tetanus is a disease of the open season.

The lowest mortality rate in tetanus is for the cases which have incubation periods of from ten to twenty-one days.

Prophylactic doses of antitetanic serum lower the incidence of tetanus and lower the mortality rate in those that develop tetanus.

Because of the many cases that develop after long incubation periods, it is thought that wounds should be more skillfully attended to and that prophylactic doses of antitetanic serum should be repeated every seven days as long as there is a possibility that tetanus infection might develop.

Because of the marked difference in the mortality rates in children and adults in this series, one might be justified in concluding that antitetanic serum is of more therapeutic value in children than it is in adults.

An initial dose of 40,000 units of antitetanic serum is adequate for many of the moderately severe cases of tetanus in children, but because it is difficult to estimate the amount of toxin that is and will be in the blood-stream, and because all cases do not improve on 40,000 units of antitetanic serum, it is thought that all children who have not an obviously mild case of tetanus should receive, as early as possible, an initial dose of 80,000 units of antitetanic serum. Such a dose would frequently obviate the need for administering additional doses at a less favorable time.

In this series the mortality rate is high for adults receiving moderately large doses of antitetanic serum. The amount of serum used was often inadequate and was frequently administered too late. For these reasons, it is thought that massive initial doses should be administered as early as possible. Because the cost of massive doses is usually prohibitive (\$3.50 per 10,000 units) a compromise of not less than 100,000 units of antitetanic serum is advocated as an initial dose for all adult cases of tetanus which are not obviously mild.

Even if symptomatic improvement occurs after the administration of large initial doses of antitetanic serum, it seems advisable to repeat doses

of 10,000 to 30,000 units of antitetanic serum for from three to five days or more.

If no symptomatic improvement follows the administration of large initial doses of serum, the patient should most certainly be given repeated doses of 50,000 to 100,000 units of antitetanic serum.

No conclusions can be drawn from the intraspinal administration of serum to patients in this series. However, the administration of antitetanic serum by the combined intravenous and intramuscular routes to children of this series has been attended by a mortality rate that compares favorably with any reported series. After a review of large series in the literature, it cannot be definitely concluded that administration of antitetanic serum intraspinally offers any advantage.

#### REFERENCES

- <sup>1</sup> Ashhurst, A. P. C.: Report on Tetanus. *Arch. Surg.*, vol. i, p. 407, 1920.
- <sup>2</sup> Freeland, S. O.: Treatment of Tetanus. *Am. Jour. Med. Sc.*, vol. clxi, p. 819, 1921.
- <sup>3</sup> Stone, W. J.: Treatment of Tetanus. *J. A. M. A.*, vol. lxxviii, p. 1939, 1922.
- <sup>4</sup> Wainwright, J. M.: Incidence and Treatment of Tetanus. *Arch. Surg.*, vol. xii, p. 1062, 1926.
- <sup>5</sup> Miller, R. H.: Report on 116 Cases of Tetanus. *Surg., Gynec., and Obst.*, vol. xxxvi, p. 90, 1923.
- <sup>6</sup> Gessner, H. B.: Therapeutics of Tetanus. *J. A. M. A.*, vol. vii, p. 867, 1918.
- <sup>7</sup> Graffagnino, P., and Davidson, J. M.: Tetanus. *New Orleans Med. and Surg. Jour.*, vol. lxxvi, p. 311, 1924.
- <sup>8</sup> Sanford, A. H.: Tetanus and War. *Internat. A. M. Museums Bull.*, vol. vii, p. 365, 1918.
- <sup>9</sup> Bruce, D.: Tetanus. *J. Hyg.*, vol. xix, p. 1, 1920.
- <sup>10</sup> Cummins, S. L., and Gibson, H. G.: Tetanus in British Army in France. *Lancet*, vol. i, p. 325, 1919.
- <sup>11</sup> Bruce, D.: Tetanus in Home Military Hospitals. *Lancet*, vol. ii, p. 925, 1917.
- <sup>12</sup> Poland: Quoted by Golla. *Lancet*, vol. ii, p. 966, 1917.

## OBSERVATIONS ON THE TREATMENT OF OSTEOMYELITIS BY THE "ORR" METHOD\*

BY IRVIN E. DEIBERT, M.D.

OF CAMDEN, N. J.

DURING October, 1927, Dr. H. Winnett Orr reported a number of cases of osteomyelitis treated by a very radical method. The results, however, to those who have had the courage to carry out this type of treatment, have indeed been gratifying.

The first thought seems to be that one is deliberately sealing up an infected wound and after using the Carrel-Dakin method of treatment in acute osteomyelitis. To treat such a case, for example, of the tibia by the technic as described by Doctor Orr, and finally applying a plaster-of-Paris casing from the tip of the toes to the mid-thigh region, without even cutting a window, seems like a radical change in treatment.

The technic as outlined by Doctor Orr is, briefly:

(1) Make a fairly large incision over the infected bone area, spread apart the skin muscles, fasciæ, and the periosteum just far enough to afford access to the diseased area and no further.

(2) Chisel a window into the infected bone area large enough so that adequate drainage is provided, all dead bone may be removed, and there are no over-hanging edges of bone over the diseased area.

(3) Clean out the diseased area gently with a curette or gouge, being careful to refrain from unnecessarily damaging the tissues undergoing repair.

(4) Dry the wound, wipe out with 10 per cent. tincture of iodine, and follow with 95 per cent. alcohol.

(5) Pack the entire wound wide open but not tightly with sterile petrolatum gauze, cover with a sterile pad and bandage on.

(6) Perform any reasonable forcible manipulation necessary to place the parts in correct anatomic position for splinting.

(7) Apply a plaster bandage, preferably, or a suitable splint so that the parts are thoroughly immobilized in a comfortable and correct position.

(8) Finally, the case is not to be split, nor are windows to be cut until the wound dressing becomes necessary, and the wound is not to be dressed at all unless there is a rise of temperature or other signs of acute sepsis. As a rule, no dressing is necessary except on account of odor, and this may not be required for several weeks.

To compare any series of cases of osteomyelitis with any other series is difficult on account of the numerous factors involved, such as age of patient, bone site and portion of bone involved, type and virulence of invading organism, individual resistance and length of time the infection has existed.

This study was started in January, 1928, in Cooper Hospital, Camden, N. J., by Dr. B. F. Buzby and the author, and is based upon 100 unselected cases of acute and chronic osteomyelitis, and compound fractures treated

---

\* Read before the Philadelphia Academy of Surgery, October 6, 1930.



by us, adhering rigidly to the technic as outlined by Doctor Orr. Prior to this time all cases of acute and chronic osteomyelitis and compound fractures had been treated by Dakinization.

Six deaths occurred in this series, all acute osteomyelitis in children in whom there had been considerable delay in the diagnosis of the condition and who were in very poor condition or moribund upon their time of admission to the hospital. All of these children showed a positive blood culture for the staphylococcus albus.

Of the deaths that occurred the distribution as to bone was as follows: one, radius; one, humerus; one, ulna; and three, femurs.

The series is subdivided as follows:

There were thirty-seven acute cases, fifty-seven chronic, and six compound fractures. The age incidence was from one to forty-seven years. The sexes were about equal, and every bone in the body is included in this series, the skull excepted.

The staphylococcus aureus and albus were the predominating organisms, and an occasional streptococcus hæmolyticus was found.

About seventy-five of these patients are clinically well. The remainder are still under treatment and a few of these are those types of patients who have had the disease from five to ten years.

These figures are believed to be those of the average hospital and are stated briefly to show the type of case which was being dealt with.

*Acute Osteomyelitis.*—Considering the acute types of osteomyelitis, with the exception of the six deaths reported, every patient was distinctly benefited by this operative procedure. They were usually free of pain on the day following operation and only in rare instances was it necessary to administer a sedative. The temperature range and pulse rate reached normal in an average of five days. It was not necessary to change any case earlier than three weeks; many were left six weeks, before the first dressing. The most striking fact during this period was the comfort of the patient, and as these patients are usually all children, one appreciates just what it means, not only to patient, but also to doctor and nurse, not to have to go through the ordeal of daily dressings.

Compare this method with Dakinization, or any other type of antiseptic treatment requiring frequent daily dressings, and it immediately becomes obvious that if for no other reason than the distinct comfort of the patient, this method is much to be preferred.

The guide as to the time for changing the dressing has been the odor. It is not felt that it is necessary to allow a plaster case to remain on until the odor becomes unbearable to the patient and his fellows. The average time for changing the case in these cases was from three to five weeks.

When the cases were opened, the wounds were found to be bathed in pus, the gauze extruded from the cavity and the entire space filled with healthy granulating tissue. Rigid aseptic technic was observed at the time of changing all cases. The wounds were protected with sterile drapes, were

## TREATMENT OF OSTEOMYELITIS

then cleansed with alcohol sponges, and sterile petrolatum gauze repacked loosely into the cavity. Sterile dressings and plaster cases were then reapplied.

In six patients, upon opening the case after an average of six weeks, it was found that the pus was no longer liquid, but of a consistency of cream-cheese, and that the wounds were practically entirely healed, and that no further inclusion in a plaster case was necessary, only a sterile dressing being applied. Of the acute cases the dressing or application of the plaster numbered from one to five, with an average of three.

These patients were kept in bed for at least two weeks after the temperature and pulse rate had reached a normal level, then were allowed to be up and about in a wheel-chair, keeping the affected part elevated. After the first dressing if the patients' general condition permitted and it was felt that they would be under competent medical supervision, they were allowed to return home, reporting to the hospital weekly, until it was time for a second dressing.

*Chronic Osteomyelitis.*—Practically the same procedure was followed in the treatment of the chronic types, operation being performed under tourniquet whenever possible. This undoubtedly saves considerable time and makes the procedure much easier.

Removal of sequestra, overhanging edges of bone and complete saucerization of the cavity was then done. The remainder of the technic was identical with that of the acute types.

Many of these patients were sent home within a week or as soon as it was certain that the infection was quiet, reporting to the hospital weekly, or as often as it seemed necessary.

Practically all of these of the chronic type were completely healed after three dressings, a few after two dressings, and some with only one, the average being between two and three.

• It was noted at the time of dressings that the defects had filled much more rapidly than in any other procedure previously employed.

Many of these patients had been operated upon before the institution of the Orr method, and had been treated by some type of daily antiseptic dressing and long hospitalization. Quite frequently these patients volunteered the information that they much preferred this type of treatment.

The question arises at this time, is it wise to immobilize the neighboring joints at this period of the disease? Will you get ankylosis and muscular atrophy? The answer is, that there has been no trouble with ankylosis in the adjacent joints; on the contrary there has been a surprising amount of motion immediately upon the removal of the plaster case.

As to muscular atrophy, that is always present to a more or less degree in every case of osteomyelitis. It is not felt that ankylosis will occur unless the adjacent joints are definitely involved by the infection.

*Compound Fractures.*—The compound fractures treated by this method were taken to the operating room immediately upon the admission of the patient to the hospital, providing, of course, that they were not greatly shocked.

They were cleansed with benzine, washed off with alcohol and swabbed with tincture of iodine. Small, loose fragments, destroyed tissue and any foreign material was removed, enlarging the wound if necessary. The wound was then packed loosely with petrolatum gauze and the part was placed in the best anatomical position possible, and whenever it was necessary to use mechanical extension, either by means of Steinman pin or ice tongs. The plaster case was applied with the extension on, the subsequent treatment being the same as that of osteomyelitis.

There are in this series only six cases of compound fractures. It must be admitted that we were reluctant to treat them by this method until we had had considerable experience in the treatment of osteomyelitis. There are at the present time about fourteen compound fractures that are progressing in a satisfactory manner, but not to be included in this report, because a sufficient time has not elapsed to be able to give a true end-result, but it is reasonable to assume that if the results continue to be as good in the future as in this small series, this will undoubtedly be the method of choice.

Of these six cases, five healed without any further treatment, one a very much comminuted gun-shot fracture of the middle of the shaft of the femur. A secondary operation for the removal of a small sequestra was necessary. These cases were about the worst possible types that one would see, so that it should be considered a fair test for the method.

(As to defects following the extensive removal of bony tissue, it has not been necessary, thus far, to resort to any plastic procedure. There is only one case in the entire series in which it will have to be taken into consideration in the future.

Dr. Clay Rae Murray, of the Presbyterian Hospital, New York City, has done much experimental and research work pertaining to this point, and has shown definitely that before bone production takes place there must be a local concentration of calcium in the adjacent tissues. Accordingly, he has filled large bone cavities with calcium salts, and obtained excellent results. As yet, this work is unpublished.

(*The Bacteriology.*—As previously stated, the predominating organisms in the cases of osteomyelitis were the staphylococcus albus and aureus. Cultures were taken at each successive dressing, and it was not unusual to find that occasionally they were sterile even on one occasion, as early as the first dressing. This phenomenon occurred five times during the entire series. The fact that one may occasionally obtain sterile cultures in infections of the staphylococcus type has been previously noted, and in relation to osteomyelitis. Albee has suggested that this may be due to a bacteriolytic substance, or the so-called bacteriophage generated within the wound itself.

Besredka and De Herrelle were the first to make and apply this substance to staphylococcic infections and have reported some excellent results. Rice, of this country, has pointed out that it fails to act in bone infections. Accordingly, Doctor Decker, who has been kind enough to give some assistance on

## TREATMENT OF OSTEOMYELITIS

the bacteriology of these infections, has been able to isolate a bacteriolytic substance from the staphylococcus albus found in these infections.

As yet, we have not had sufficient time or experience to arrive at a definite conclusion. We hope to report on this point at a later date.

This is offered as one of the possible points which seem to influence a more rapid and complete healing by the Orr method.

Bone production and bone resorption show an extremely narrow margin. Where does the former stop and the latter begin? What factors control them? The pH of the blood and local tissues plays an important part. That bone production takes place in the presence of infection, there is no doubt. That there must be anædematous infiltration for the multiplication of connective tissue, and the subsequent deposition of calcium into this new tissue, has been adequately established by Leriche and his co-workers. Is it wise, then, to wash away or destroy these vital elements of new bone production, with antiseptics, that never succeed in sterilizing the wound? These are offered as other points in favor of this method of treatment.

### SUMMARY

(1) One hundred cases of acute and chronic osteomyelitis and compound fractures treated by the Orr method have been reviewed. No attempt at a definite comparative study with other methods has been made.

(2) The Orr method of treatment has proven very satisfactory and it is believed to be the method of choice in the treatment of osteomyelitis. It permits a most certain individual attention which is not possible under the daily dressing routine.

(3) The time of wound healing is considerably shortened and the bony defects are less.

(4) The early or primary removal of as much diseased bone as possible lessens the amount of subsequent sequestration, and the number of secondary operations.

(5) The closed plaster bandage lessens the liability to secondary or mixed infection and does not in itself cause ankylosis of adjacent joints.

(6) From an economic standpoint the number of dressings and the time consumed are considerably less, nor is it necessary to hospitalize the patient the length of time needed for other types of treatment of this disease.

(7) Finally, it is far and away the most comfortable type of treatment from the standpoint of the patient.

### REFERENCES

- Albee, F. H.: *The Principle of the Bacteriophage Applied to Osteomyelitis*. Int. Journ. Med. and Surg., vol. xlii, p. 1, 1929.
- Besredka, Prof. A.: *Local Immunization, Specific Dressings*. Williams and Wilkins Co., Baltimore, Md., 1927.
- Brickner, Walter M.: *Chronic Osteomyelitis*. Amer. Journ. Surg., vol. iv, p. 476, 1928.
- Bromer, Ralph S.: *Infectious Osteomyelitis, Differential Diagnosis*. Amer. Journ. Roentg. and Radium Therapy, vol. xvii, p. 528, 1927.

IRVIN E. DEIBERT

- Hallilay, H.: Chronic Osteomyelitis: Long Bones. *The Lancet*, vol. xi, p. 490, 1928.
- Kleinberg, Samuel: Chronic Osteomyelitis. *Amer. Journ. Surg.*, vol. iv, p. 475, 1928.
- Leriche, R., and Policard, A.: Trans. by Moore and Key: *The Normal and Pathological Physiology of Bone*. C. V. Mosby Co., St. Louis, Mo., 1928.
- Orr, H. W.: *The Treatment of Osteomyelitis and Infected Wounds by Drainage and Rest. Surg., Gynec., and Obstet.*, vol. xlv, p. 446, 1927.
- Idem.* *Nebraska State Med. Journ.*, vol. xii, p. 222, 1927.
- Idem.* *Journ. of Bone and Joint Surg.*, vol. ix, p. 733, 1927.
- Idem.* *Methods and Results in Osteomyelitis. Nebraska State Med. Journ.*, vol. xii, p. 452, 1927.
- Phemister, D. B.: Unusual Forms of Osteomyelitis. *North West. Med.*, vol. xxvii, p. 460, 1928.
- Rice, T. B.: Bacteriophage in Suppurative Conditions. *Indiana State Med. Journ.*, vol. xxi, p. 509, 1928.



# TRANSACTIONS

OF THE

## PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD MAY 5, 1930

The President, DR. GEORGE P. MULLER, in the Chair

CALVIN M. SMYTH, JR., M.D., Recorder

### INTRAHEPATIC CHOLELITHIASES

DR. WILLIAM B. SWARTLEY reported the case of a man sixty-seven years of age, a painter, who was admitted to the medical ward of the Germantown Hospital August 22, 1929; complaining of pain in the right upper quadrant of the abdomen, jaundice, chills and fever.

He had had the usual diseases of childhood and gonorrhœa. He had never had typhoid fever. The family history was irrelevant.

Two days previous to admission to the hospital he had a mild pain in the right upper quadrant of the abdomen which became severe the next day, and radiated to the right scapular region. This pain was colicky in character and never entirely disappeared. The stools gradually became lighter in color and constipation was pronounced. The urine was highly colored. With the onset of these symptoms he had chills and fever. Previous to this attack, he was not constipated, but had difficulty in digesting fatty foods. Two years ago, he had an attack similar to this one except that the pain was not so pronounced. He did become jaundiced, however, but at that time, a diagnosis of lead poisoning was considered because of his occupation. There were no symptoms of peripheral nerve involvement or severe constipation. He has had a severe grade of pyorrhœa and much trouble with his teeth. Occasionally, he has had indigestion, belching of gas, and usually vomits during an attack of this nature. He has lost twenty pounds in weight during the past year.

When admitted, there was decided tenderness and rigidity of the right upper quadrant of the abdomen. The liver margin could be felt three fingers' breadth below the costal margin but the gall-bladder could not be palpated.

Five days after admission to the medical ward, the jaundice had considerably lessened and the patient was transferred to the surgical ward, but his improvement was so decided that he refused operation until September 12, 1929, when he had another acute attack of vomiting and pain with increased jaundice.

At operation, on September 25, the gall-bladder was found normal in size, not tense, walls thin, and it contained no stones. When passing deeper under the liver in the neighborhood of the porta hepatis (a "quarry" of stones was palpated. An incision was made into the duct containing these stones and sixteen large stones, three to ten millimetres in diameter, black in color and faceted, were removed. The incision into the hepatic duct was large enough to admit a finger so that the stones could be palpated. Most of them were in the hepatic duct, but a few were found in the common bile-duct. One stone, slightly smaller than the ones removed from the hepatic duct, was lodged high up in a duct in the liver; this could not be removed, but could be palpated. Because of the condition of the patient, it was decided that

further manipulation or destruction of tissue was not justifiable and the stone was allowed to remain. The liver was enlarged and showed evidence of hepatitis. The pancreas also was very hard throughout. The gall-bladder was then opened to make certain that there were no stones present. A rubber tube was sutured into the gall-bladder and a large rubber "T" tube was placed into the hepatic and common ducts for bile drainage and a cigarette drain deep into the transverse fissure and the abdomen closed.

Convalescence was normal. The drainage from the "T" tube was free. The tube in the gall-bladder was removed on the eleventh day. All jaundice had disappeared and on the twenty-eighth day the remaining tube in the hepatic and common ducts was clamped. No jaundice developed and the patient's appetite improved and he gained strength. On the fortieth day, the "T" tube was removed. There was very little bile drainage the next three or four days after the removal of the tube. Ten days after its removal, the wound was healed and the patient discharged, 11-14-29.

Lewisohn<sup>1</sup> states that at the time he wrote his article (May, 1916), "the surgical literature of intrahepatic calculi is a very small one; it comprises only two cases (Hawkes and Noguchi). Noguchi removed a solitary stone from a patient thirty-four years of age, from the hilus of the liver. The stone had a diameter of one and one-half centimetres. Noguchi reports that the exposure of the operation field was by no means satisfactory. It may be doubted whether Noguchi's interpretation of his case (solitary intrahepatic stone) is a correct one. It is very possible that he was dealing with a solitary stone in the cystic duct which had perforated into the surrounding tissue, where it became encapsulated. The gall-bladder was not removed in this case."

In Doctor Swartley's case, the gall-bladder contained no stones and was normal in every respect to gross examination, and, therefore, no adhesions binding it to the quarry of stones under the liver. These stones were removed by opening the bile-duct proximal to the cystic duct (easily located) that is the hepatic duct. Since this quarry of stones was located in the hepatic duct just outside the porta hepatis, and one at least could be felt higher in the liver bile-ducts, waiting to drop down into the quarry with the others, one naturally would think the liver to be the source of origin in this case. The reporter remarked that there may be hundreds more above the one that he palpated and could not remove, as there was in a case that was operated upon by the late Dr. Francis T. Stewart, which case he did not report. His case was operated upon three times for gall-stones. After the third operation, in the Germantown Hospital, the patient died. It was the speaker's duty to perform an autopsy on this patient.

At his operation, the common and hepatic ducts were filled with a material of a putty-like consistency which was removed. At the autopsy the bile-ducts were opened from the transverse fissure throughout their entire extent to the very thin margins of the liver, and gall-stones were found in great numbers, larger toward the central main duct and gradually graded smaller toward the periphery like a string of beads. Lenhartz had just this type of

## INTRAHEPATIC CHOLELITHIASES

case. Lewisohn shows the picture of the liver of Lenhartz's case in his article.

Since Doctor Swartley's patient left the hospital he has had no jaundice, pain in the abdomen nor chills and fever. Even though we know he had a stone retained in the liver, it could have passed down into the hepatic duct and out through our "T" tube drainage. However, no such stone was found in the bile drainage receptacles or on the dressings after the operation. In Judd and Burden's case,<sup>2</sup> they mention that their patient had no clinical evidence of a stone in the liver. In the case now reported there may have been only this one or he may have had hundreds more. With the view of determining this possibly by X-ray, an X-ray was made May 1, 1930. There was a shadow shown in the area of the porta hepatis which the radiologist, however, would not definitely interpret as a stone.

BEER, LEWISOHN, ERDMANN, and JUDD have all written interesting articles on Intrahepatic Cholelithiasis.

BEER, in 1904 (*Med. News*, vol. lxxxv, 1904), studied this condition most thoroughly by dissecting 250 livers of patients who had died of gall-stone disease and found gall-stones in the hepatic ducts within the liver in six cases (2.5 per cent.). He has given three different causes for their formation; first, obstruction; second, cholangitis; and third, an unknown factor (diathesis?).

LEWISOHN, in 1916 (*op. cit.*), was induced to report his case because of (1) the extreme rarity of the condition in surgical pathology; (2) the fact that his case was the first case in which intrahepatic stones had perforated, thus causing a localized peritonitis; (3) the interesting observation that a biliary fistula which persisted for eight months, closed spontaneously (and has remained closed for four months), though the hepatic ducts, and very probably the common duct, are filled with stones.

J. F. ERDMANN, in 1918 (*International Clinics*, vol. 28, pp. 111, 131, 1918) in his article speaks of these cases as the "bête noir" of the surgeon. The first man goes in and removes a handful or more of gall-stones, the symptoms return and the patient consults another surgeon. He operates and removes the gall-bladder, and says, "Now this patient can have no more gall-stones, for the gall-bladder has been removed." But he forgets the intrahepatic passages. The stone-producer may be present in the small branches of the biliary system, due to the staphylococcus, the streptococcus or the colon bacillus, *etc.*, and this may give trouble even twenty-five years after an operation has been performed and the gall-bladder removed. In an intrahepatic case, there is no question that the stones may come down at successive times and one cannot guarantee to relieve the patient permanently by one operation, but in 92 to 95 per cent. of the cases, there is no recurrence, while in the remaining 5 to 8 per cent. we must expect to get a recurrence.

JUDD and BURDEN, in 1926, reported a case in which they state that the unique features which form the subject of their report are: "The finding of many large intrahepatic calculi in a liver which was grossly normal, more than eleven years after cholecystectomy; and removal of numerous stones from the extrahepatic ducts; and the presence of this condition without the occurrence of jaundice or any clinical evidence of hepatic insufficiency, the condition being an incidental finding in a patient who died from intestinal obstruction."

## PHILADELPHIA ACADEMY OF SURGERY

### REMOVAL OF RUBBER TUBE FROM COMMON BILE-DUCT

DR. EDWARD J. KLOPP reported the removal of twenty-six centimetres of a No. 24 soft rubber catheter which had been used, after the method of Duval and Richard, in repairing a stricture of the common bile-duct on April 12, 1926, and presented at a meeting of the Academy held February 7, 1927. The man was aged thirty-six at the time of that operation and had many attacks of abdominal discomfort, gaseous eructations and constipation but was able to work as a clerk.

In April, 1929, the abdominal discomfort increased, the "gas would move from place to place." He was obliged to use laxatives and enemas about every three days. A gastro-intestinal X-ray with a barium meal failed to reveal any evidence of obstruction. In February, 1930, the discomfort became more marked. There was constant pain above the umbilicus. He became slightly jaundiced and was admitted to the Pennsylvania Hospital February 24. His stools were clay-colored and there was itching of the skin. Another gastro-intestinal X-ray showed no evidence of obstruction. The stomach emptied in two and one-half hours.

March 7, 1930, the tube was removed under spinal anaesthesia. There seemed to be fewer adhesions than at the two previous operations. The tube was easily felt in the duodenum, also in the common bile-duct. An attempt was made to dislodge the tube by gentle manipulation of the duodenum. This was unsuccessful. The duodenum was then opened and the tube removed without much resistance. Bile promptly appeared in the duodenum. The common-duct area was palpated (but not probed) for evidence of stone; none could be demonstrated. The hepatic ducts were so buried in adhesions that identification was out of question. The duodenum was closed with two rows of catgut sutures. The suture line was reinforced with omentum.

Two days after the operation there was evidence of peritonitis, resulting in death on the fourth day.

The tube removed was described by the pathologist, Dr. I. J. Wolman, as follows:

"The specimen is a piece of rubber tubing measuring twenty-six centimetres in length and one centimetre in diameter. It is somewhat curved in shape but its ends project straight outward. One end for a distance of six centimetres is crusted with a dry, orange-yellow deposit, not very abundant, but enough to cover the surface. This end has a funnel-shaped dilatation with a diameter of 1.3 centimetres. The remainder of the tube is dark green on the surface, through which the underlying red rubber shows through little cracks. In opening the tube it is found that the gall-bladder end is filled with granular, friable yellow deposit similar to the incrustation on the surface. The deposit has apparently completely blocked the terminal dilatation and almost completely fills the lumen for six centimetres. Beyond that there is a less abundant yellowish-green deposit on the inner surface which extends for the remaining entire length of the tube with the exception of the terminal seven centimetres. The rubber still retains a little of its elasticity. It is red in color. The line of demarcation between the superficial crust at the end which was located at the side of the gall-bladder and bile-ducts and the distal green color, is abrupt and at the site of transition the tube appears a little constricted for a length of one centimetre proximal to the transition."

Autopsy revealed a moderate amount of bile-stained, purulent fluid. There was an abundant yellowish exudate about the suture line of the duodenum, but no defect was demonstrable.

The points of note were that the liver was slightly enlarged; the larger ducts were dilated and contained numerous, irregular, granular concretions; eight of these were .5 centimetre in diameter. There was a soft stone two



## FOREIGN BODY IN HEART

centimetres in diameter at the junction of the hepatic ducts, and one, half that size, above in the right hepatic duct.

The common duct was dilated with a diameter of about 1.2 centimetre, wall was thickened, fibrous, and the inner surface was congested and dull in appearance. Five centimetres from the ampulla of Vater on the inner aspect there was a small ulcer-like defect (absence of mucous membrane) three centimetres in diameter. The edges were indurated. Bands of scar tissue were visible radiating out in all directions from its margin. There was a small opening through which a probe could be passed, permitting the escape of bile.

The reporter thought it was a mistake to use a catheter of such large size. There had been two previous attempts to relieve the stricture, one by himself. He was especially eager to prevent another failure. A second error was that the catheter should have been removed long before. One should anticipate the formation of stones. He questioned whether the catheter should have been permitted to remain more than twelve or eighteen months.

DR. GEORGE P. MULLER said that he agreed with Doctor Klopp that it is not a wise procedure to attempt to implant a "T" tube when dealing with the stricture of the common duct. The strictured part seems to extend right to the end of the duodenum. After exposing the area of stricture, it is better to pause a moment to decide what to do and an immediate hepaticoduodenostomy will often give the best result. He has had four this year. He also thought the point was well taken regarding the use of a tube sufficiently small so that it will be easily swept on into the duodenum.

## FOREIGN BODY IN HEART

DR. J. R. VEAL, by invitation, presented a man, thirty-nine years of age, who was admitted to Doctor Mitchell's service at the Pennsylvania Hospital at 9:10 A.M., April 26, 1930, with a history that twenty minutes previously he had been struck over the heart by a block of wood thrown by a circular saw.

On admission, patient was cold and clammy, blood-pressure 54/40, pulse 96, poor volume but regular. Over pericardium in the third interspace, just above and to the inside of the left nipple, there was a small, apparently superficial laceration which had bled slightly. Careful examination of the thoracic wall revealed no signs of injury to ribs or sternum. The heart was in normal position; was not enlarged to percussion; the sounds were very weak and distant; rate 96; rhythm regular; no murmurs or adventitious signs were noted. There was definite restriction of expansion in the left lower chest, breath sounds were weak and distant in this area. No râles were noted. Respiration 28. Chest otherwise negative. Abdomen was rigid especially in the upper left quadrant. There were no signs of contusion or external injury to abdominal wall. No shifting dullness in flanks. Physical examination was otherwise negative.

Under treatment the patient gradually improved, his blood-pressure rose to 96/70. He complained bitterly of pain in epigastrium and upper left quadrant. His heart rate remained around 90. He vomited several times, the vomitus containing no blood. Throughout the day the patient continued in this condition. On the following day, at 9:30 A.M., twenty-four hours after accident, blood-pressure was 90/60, pulse 110, temperature 100°, and he continued to complain of intense pain in upper left abdomen. The abdom-



inal rigidity was less marked, and there was no further evidence of injury to any other abdominal organ. The patient was incontinent. There was no bleeding from laceration noted above. The heart rate was 110, sounds weak, poor quality, rhythm regular. The heart was in normal position and not enlarged to percussion. There was a slight impairment over left lower chest with a few crackling inspiratory râles.

At 9 P.M. on this same day the patient's temperature rose to 104, pulse 120 and he became very restless and had to be restrained in bed. His pain continued as above, morphine and sedatives having little effect upon it. At this time the left lower chest revealed signs of consolidation. The heart borders could not be outlined but seemed to merge with the dullness in the left lower chest. The patient soon went into shock again and his condition gradually grew worse. Heart rate was 130, sounds very weak, rhythm regular, pulse imperceptible. Both lungs were filled with bubbling râles and

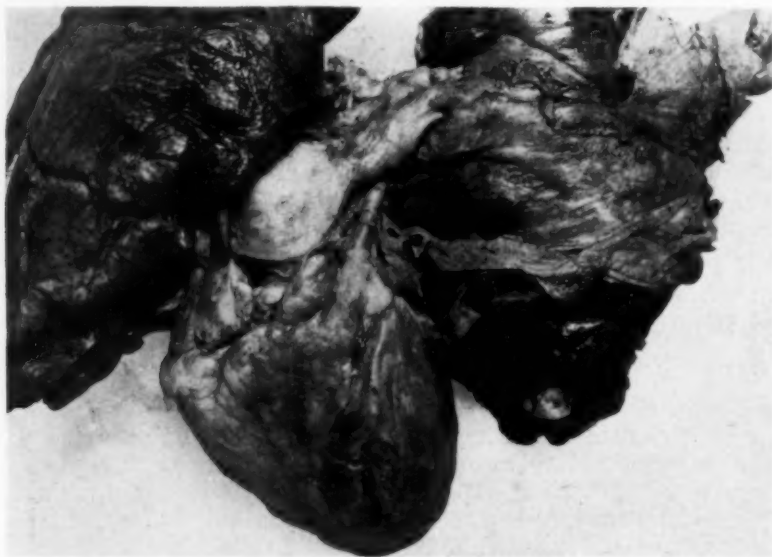


FIG. 1.—Anterior surface, showing heart and lungs, with splinter piercing heart.

respiration became quite rapid. Patient died at 6:30 A.M., April 28, forty-six hours after initial injury.

*Post-mortem examination.*—The body is that of a muscular male, estimated to weigh 160 pounds. It appears normal externally except for a small skin lesion located 1.5 centimetres medially and slightly cephalad to the left nipple. This lesion has an area measuring .8 by .6 centimetre. It is brown and dry and appears as if pressure atrophy of the skin had occurred. There is no evidence of perforation but probe can be passed through it into the underlying tissues.

The left lung is collapsed and the pleural sac filled with 2000 cubic centimetres of dark red blood, partially clotted. There is a small perforation 0.5 centimetre in diameter in the parietal pericardium, beneath the superficial skin lesion. The pericardial sac is filled with clotted blood. There is also a dull fibrinous exudate on the surface everywhere. Projecting upwards from the anterior surface of the heart from the middle of the left ventricle is a blood-stained splinter of wood. (Figs. 1 and 2.) The splinter measures nine centimetres in length and is pyramidal in shape, its base being about one centimetre square. Its sides are irregular and grooved. The point is fairly sharp. The splinter has entered the heart through the left ventricle wall on the anterior surface. When removed the wound gaps open and blood flows from the heart. The splinter has

## NECROSIS OF BONES OF FOREARM

perforated the heart and a few millimetres of its tip appears on the posterior aspect of the left ventricle. The heart itself is contracted and not hypertrophied. The great vessels seem normal. It is not opened but preserved intact as a museum specimen. The left lung is somewhat collapsed. The right lung is somewhat voluminous. No consolidation is found anywhere. There is no blood in the right pleural cavity and no exudate on the surface.



FIG. 2.—Showing length and size of splinter with portion of skin showing where splinter entered the chest wall—nipple, etc.

### CHOLECYSTOSTOMY

DR. BRUCE L. FLEMING, by invitation, read a paper entitled "An Investigation of the Functions and Symptoms of the Surgically Drained Gall-bladder."

### LYMPH EXUDATE AND FIBROUS TISSUE

DR. EDWARD T. CROSSAN pronounced the annual oration on the above-titled subject for which see page 1019.

### STATED MEETING HELD OCTOBER 6, 1930

The President, DR. GEORGE P. MULLER in the Chair

### NECROSIS OF BONES OF FOREARM FOLLOWING TRAUMATIC REMOVAL OF PERIOSTEUM

DR. GEORGE M. DORRANCE reported the case of a man admitted to St. Agnes' Hospital, September 4, 1928. The forearm had been injured in a wringer. A large amount of muscle, tendon and fascia had been torn away

from the anterior and posterior surface. The periosteum seemed to be denuded from the area that subsequently sequestered. The wound became infected and was treated by Dakin's oil. An X-ray plate taken September 11, 1929, showed the bones of the forearm and wrist normal. Three weeks later another series of plates showed an area of beginning necrosis. On December 14 the X-ray plates showed a free sequestrum in each bone (Fig. 1). By January 17, 1930, the X-ray showed the ends of the bone had approximated each other and union was taking place between the end of the radius and between the two lower ends of the radius and ulna. The speaker remarked that if the whole end of the bone had become necrotic, he could understand that the circulation to the bone marrow had become obstructed. However, it



FIG. 1.—Post-traumatic necrosis of radius and ulnar. Condition three months after injury.

was difficult to explain the localized necrosis unless they were dealing with injury to the overlying periosteum followed by secondary infection.

#### BLASTOMYCETIC OSTEOMYELITIS OF FEMUR

DR. BENJAMIN F. BUZBY reported the case of a boy, aged eleven years, who was admitted in the Orthopædic Service of Cooper Hospital November 7, 1927, with the complaint of swelling of the left thigh, pain in the left hip on motion, on walking, and on exposure to cold.

The family history was negative. His own health had always been good.

He dated his present disability to a fall he had had two and a half years before when he injured his left thigh. He recovered from this in a short while and was free from symptoms except aching in damp weather until two weeks before admission, when he noticed swelling of his left thigh and pain on use.

Examination showed him to be a fairly well-nourished boy in no apparent discomfort. His temperature was  $99.4^{\circ}$ , pulse 120, and respirations 24. There was a slight enlargement of the heart with a presystolic thrill and a low-pitched presystolic mitral stenotic murmur with accentuation of the pulmonic second sound. Except for the condition of his left thigh his examination otherwise was negative. His left thigh was considerably enlarged in its upper third where there was localized heat, redness, and induration over a small area on the antero-lateral aspect. The skin was freely movable over this mass, and the mass seemed unattached to the underlying bone. There was no fluctuation. The blood count was: erythrocytes, 4,790,000; hæmoglobin, 80 per cent.; leucocytes, 13,100 with 71 per cent. polymorphonuclears, 26 per cent. lymphocytes, 1 per cent. large mononuclears, and 2 per cent. transitionals. The urine was negative. The Wassermann was negative. November 8, 1927,

## BLASTOMYCETIC OSTEOMYELITIS OF FEMUR

an attempt was made to aspirate this mass but only a few drops of blood were obtained which gave a sterile culture. November 8 his white blood count was 10,200. November 14 an exploratory operation was done. When the periosteum was incised and elevated much necrotic material and some pus were evacuated. The patient's condition became alarming when the bone was exposed and the wound was packed with gauze and the operation stopped. Culture from under the periosteum showed staphylococcus albus. Tissue removed at the same time, when examined microscopically, was infiltrated with pus, lymphocytes and other exudative cells. For the next three days his temperature averaged about 100°, but his pulse, which was 176 at the cessation of the operation, returned to 126 within twenty-four hours. Two days later,

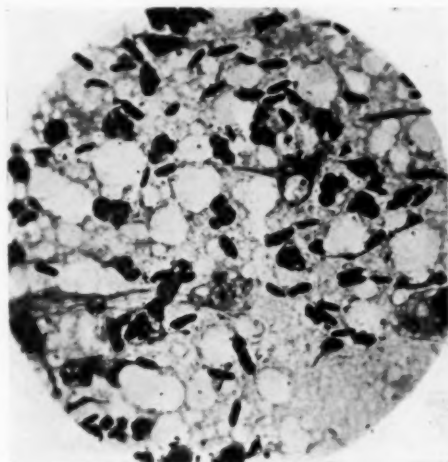


FIG. 2.—Smear showing pus cells and cigar-shaped spores, obtained at primary operation.

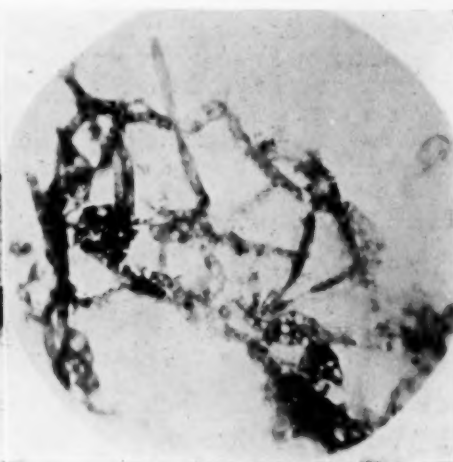


FIG. 3.—Smear showing typical growth of organism, obtained from culture.

under anaesthesia, the packing previously placed was removed, and a typical saucerizing operation was done, after removal of all the necrotic tissue. No sequestrum was found. The wound was packed with gauze and a dry dressing applied. There was an excessive amount of post-operative oozing which continued for several days. His temperature by now was normal, pulse 110. The bleeding was controlled by packing by this time and his blood count, under liver diet, haematinics and high caloric diet, improved constantly. Much difficulty was encountered in getting a donor so no transfusion could be given early, but December 13 a transfusion of 300 cubic centimetres of whole blood was given. He was discharged from the hospital January 8, 1928, with his wound healing well by granulation, feeling quite fit and with a normal blood count.

The boy did well until about August 1, 1928, when he noticed a small, tender swelling in the popliteal space. This gradually became larger, until on readmission to the hospital on August 19 there was a tender swelling filling the left popliteal space which was constantly aching on use, but with no limitation of function of the knee. There was slight increase in circumference on the affected side. The temperature was normal, pulse 100, and respiration 20. The urine was negative and the blood count showed a slight secondary anaemia. Former X-ray had shown thickening of the femoral shaft only, but now there were two cavities, each 1 centimetre in diameter, presenting about 6 centimetres above the intercondylar notch. The abscess was evacuated and the affected bone area saucerized. The pus resembled staphylococcal pus in

appearance. No sequestra were encountered. The wound was treated by the Orr technic for osteomyelitis with a plaster bandage applied from the toes to the upper thigh. The smear from this pus showed many pus cells and many cigar-shaped, large, spore-like bodies, but no pyogenic bacteria. The culture report, when finally submitted by Dr. F. L. Weidmann, from the University Laboratories of Dermatological Research, who had been working on it in conjunction with Dr. D. L. Farley, read in part, "This is a strange yeast to me. It appears to belong to the *Monilias* and is probably a valid pathogen according to the clinical pathological circumstances in the case, but we have run into a very common experience in fungus work, namely, fungi can only successfully invade tissue where receptivity is just right on the part of the host." This report was made after repeated animal inoculation and growth on various types of culture media. It is interesting to note that at the first changing of the plaster case an attempt was made to obtain the same growth from the uncontaminated wound but this culture was sterile and direct smear showed only pus cells.

Convalescence from this operation was uncomplicated and he was discharged from the hospital on September 20 with a plaster case from his toes to his upper thigh and walking with crutches. His upper thigh wound was healed at this time and the lower wound progressing satisfactorily. On December 4 a caliper walking brace was applied and weight bearing with crutches permitted.

On December 27 he was readmitted to the hospital with an area of redness presenting on the inner aspect of the lower thigh which was hot and tender but showed no fluctuation. At operation no pus was encountered and no culture taken but upon cutting through the periosteum and stripping it back it was found that a superficial layer of cortex was adherent to the periosteum and came away with it leaving a comparatively smooth non-bleeding surface. These fragments were carefully removed and the wound packed with vaseline gauze and, after exploring the popliteal wound and removing from it a small fragment of necrotic bone, a plaster splint was applied. There was quite a sharp post-operative reaction with pulse up to 160 and temperature to  $103^{\circ}$  but the pulse was 100 and temperature normal within a week. The splint and packing were removed on January 7, 1929, and his brace reapplied. He was discharged from the hospital in excellent condition, following which time this wound rapidly closed in and he has had no further symptoms in his thigh and has retained full function of his knee-joint.

He was readmitted to the hospital on July 24, 1929, with involvement of the lower end of the tibia. This area was opened and saucerized according to the Orr technic and a plaster case applied. A culture from this abscess showed *staphylococcus albus*.

He has had a persistent sinus in the popliteal space, the area from which this yeast organism was primarily obtained, but the amount of discharge has been only slight and serous in character in large part.

DOCTOR BUZBY remarked that the literature on blastomycetic osteomyelitis is scanty with practically all the cases reported being fatal, the osteomyelitis being a part of the general systemic infection in which the lung, skin and bone are the commonly involved structures with the spleen, kidney, liver, lymph-nodes and brain following in that order of frequency according to the report of Wade and Bel in twenty-two autopsied cases. They note that small abscesses are found in the liver and spleen while large ones invade the joint and cause secondary erosion and caries of bone.



## BLASTOMYCETIC OSTEOMYELITIS OF FEMUR

Dickson's case was secondary to a pulmonary infection and the patient died in a few months from multiple generalized abscesses following a course of general pyæmia, the bone abscesses having been continuous with the soft tissue or lung collections of pus.

Wrede maintains that all bone abscesses are not metastatic but arise by continuity of infection and contiguity of structures and the bones most commonly affected are those near the respiratory and alimentary systems, as the blastomycetic infection enters the blood-stream through these portals and not through the skin. He further believes that when the process begins in the skin it extends to the periosteum and then on into the medulla, showing first peripheral caries. Respiratory system infection leads eventually, however, to metastatic infection.

Ryerson's cases were systemic and pulmonary in origin, were fatal and both resembled multiple tuberculous abscesses.

Connor's report is mainly a bacteriological one but his patient had a lesion of the humerus with many sinuses about the elbow, and a lesion of the os innominatum with abscesses on the buttocks. The patient was in apparent good health with no fever or leucocytosis. He also fails to place the causative organism in a definite classification due to its changing characteristics in culture media. The outcome of this one is not stated.

Chifalieu's case closely resembles the one here reported in that it was in a woman, aged twenty-five, who had been ailing for four years before admission with swelling, redness over the lower femur and limitation of motion in the knee. Her primary diagnosis had been tuberculosis or chronic osteomyelitis. At operation there was found a gelatinous albuminous exudate about white non-bleeding bone with a large single cavity in the lower end of the femur. The bone was treated by washing with ether and packing with gauze. The patient recovered fully but had a serous discharge from an overlying sinus lasting several months. This was thought to be secondary to a vesicant applied to the chest wall four years before symptoms began and eight years before adequate treatment was instituted.

In looking backward over the case herein presented several features make it appear quite different from ordinary chronic osteomyelitis, of which this boy has had two apparent attacks, the upper femur and the opposite tibia, from both of which staphylococcus albus in pure culture was isolated.

1. Low white blood cell count—7,400 when the *Monilia* was the causative agent as against 13,100 when the staphylococcus was isolated.
2. Low temperature and rapid pulse.
3. Superficial dry necrosis of the cortical bone with lamination of the subperiosteal layers of bone.
4. The generalized thickening of the femoral shaft without history of serious preceding or accompanying symptoms until abscess formation became apparent.

From his continuous appearance of good health surely a source of infection in the lung or gastro-intestinal tract can be ruled out, which would leave either his chronic facial eczema or less likely the slow-healing gunshot wound of his palm as the portal of entry of the yeast infection. Even thus it is hard to explain the two different types of organisms found in the three separate bone abscesses. The infection must have been hæmatogenous in

## PHILADELPHIA ACADEMY OF SURGERY

origin with the primary focus long since entirely obliterated, for he never had an overlying skin lesion.

### BIBLIOGRAPHY

- Bassac, P.: *Jour. Infectious Diseases*, vol. iii, pp. 91-101, Chicago, 1906.  
Deckson, E. C.: *Arch. Int. Med.*, vol. xvi, pp. 1028-1044, Chicago, 1915.  
Feumogolli, C. R.: *Ann. d'Anat.*, vol. iv, pp. 513-129, 1927.  
Parker, C. A.: *Jour. Bone and Joint Surg.*, pp. 759-777, Boston, 1923.  
Wade and Bel: *Arch. Int. Med.*, vol. xviii, pp. 103-130, Chicago, 1916.  
Connor, C. L.: *Jour. Infectious Diseases*, vol. xliii, pp. 108-116, Chicago, 1928.  
Wrede, L.: *Verhandl. d. deutsch-Gesellsch. J. chir.*, vol. xxxv, pp. 419-427, Berlin, 1906.  
Chifalieu: *Bull. Acad. de Méd.*, 3. S., vol. lxx, pp. 509-513, Paris, 1913.  
Ryerson: *Amer. Jour. Orth. Surg.*, vol. ix, pp. 79-83, Philadelphia, 1908.

### TREATMENT OF OSTEOMYELITIS

DR. IRVIN E. DEIBERT, by invitation, read a paper entitled "Observations on the Treatment of Osteomyelitis by the Orr Method" for which see page 1087.

DR. ELDRIDGE L. ELIASON said that Doctor Orr has placed emphasis on two or three points; one is proper drainage, the other is rest, and that rest means rest by splinting and rest from the over-zealous dresser. Most surgeons seem to have come to the conclusion that acute osteomyelitis is no longer a subject for a long incision and canalization the full length of the bone and a curette, scraping out all the medullary cavity after having pushed back the periosteum to its full extent and thereby exposing raw bone for infection. Today the consensus of opinion is that acute osteomyelitis is best treated by as small and adequate an incision as can be accomplished for the purpose of drainage, which is a point the author brought out by the Orr treatment. This can be accomplished by a small incision and a drill or burr hole in the bone in the desperately sick patients. The crux of the matter is—does the Orr method deliver lower mortality and morbidity? The mortality of acute osteomyelitis is higher than it should be. Mormier in 779 cases and Lewis, of Baltimore, in 260 cases, have found the mortality between 15 and 17 per cent. In the whole series, acute and chronic, it was somewhere between 4.5 and 5 per cent. They also have shown in the vast majority of cases of acute osteomyelitis, that the patients reach the hospital after the disease is four to seven days old. Therefore, the disease has progressed and in very many instances has become, or at least is, at the time of admission, a blood-stream infection. Therefore, the early diagnosis based upon point tenderness and the advantages offered by the Orr treatment should help us to improve mortality and morbidity in the acute cases. Doctor Deibert spoke of the daily dressings of the wounds treated by dakinization; he probably means frequent dressings. Furthermore, most of us, although we may not follow the Orr technic absolutely, at least approximate it by the use of paraffin mesh and vaseline gauze, loose dressings in the wound, and the dressing of the cases after allowing them to go five to six days after operation. Doctor Eliason has had no experi-

## TREATMENT OF OSTEOMYELITIS

ence in treating open compound fractures by the Orr method, but thinks if it applies in the other instances it might apply to them also.

DR. CALVIN M. SMYTH, JR., said that in the past year he had treated fourteen cases of open fracture by this method; twelve fractures of the leg, one of the femur, and one of the forearm. In no instance has he had cause to regret employing the method. The objectionable odor in osteomyelitis cases is not often encountered in the fracture cases, unless a good deal of infection had taken place. He feels that probably a little too much emphasis has been placed on vaselized gauze and that possibly some other things would do just as well, iodoform, for instance, or gauze saturated with dichloramine-T.

He usually removes the case at the end of four weeks because after doing a few of these operations he found the gauze was extruded from the wound by granulation at that time and one usually found a clean, red, granulating wound that required no further packing. In these fourteen cases it had not been found necessary to open the enveloping bandage, and the results had been uniformly good. A very important point in treating fractures by this method is to recognize anaërobic infection and to deal with it should it occur.

DR. B. F. BUZBY stressed the necessity of complete removal of overhanging bone and all necrotic bone, and in acute osteomyelitis the question is getting patients to the hospital sooner. In the past year, on each of three successive Saturdays, three late osteomyelitis cases were admitted to the speaker's service, two of the femur and one of the radius. In one instance the patient had been sick for three weeks, another two and a half weeks, and one of the femur, sick one month, he thought was going to die on the table. This child disappeared at the beginning of the summer and reported back at the end of the summer with function practically normal in knee and hip. In the question of drill hole and the burr hole, Doctor Buzby took issue with Doctor Eliason because during the time covered by this series he has done them both ways and he has had more secondary sequestrectomies from the drill hole, while he has had none from primary removal of overlying cortex by a chisel. With drill holes, burr holes or trephine, the edges of the bone have died, possibly from the heat of the drill, and secondary operations have had to be done.

DR. DEFORREST WILLARD said that patients treated by the Orr method are more comfortable than others, and this is one of the great advantages of the method. He thought if the patients in the same ward were deprived of the sense of smell they would all be more comfortable. The odor, as the case gets older, is something beyond belief. If one made the first dressing in two weeks as Orr first advocated, one could do away with the objectionable features of this treatment and give the patient a very thorough method of treatment with a minimum of pain during convalescence.

DR. LEE A. RADEMAKER said that studies regarding bacteriophage might have a practical application in connection with the method of treatment under discussion. Every organism has a certain amount of bacteriophage which can be brought into usability by certain procedures. It is interesting to

## PHILADELPHIA ACADEMY OF SURGERY

speculate upon the question as to whether, in a localized infection in which constant drainage is allowed to take place, the phage acts to destroy the infecting organism. In two cases of osteomyelitis treated by Doctor Muller and the speaker, bacteriophage was deliberately introduced into the wound and it showed rapid improvement. Doctor Rademaker mentioned this merely as a possible explanation of the good results obtained by what on first glance would appear to be an unreasonable surgical procedure.

### CORDOTOMY FOR THE RELIEF OF PAIN

DR. FRANCIS C. GRANT read a paper with the above title for which see page 998.

DR. CHARLES H. FRAZIER remarked that there is no question but to Doctor Spiller belongs the credit for conceiving this method of controlling pain in the trunk and lower extremities, no matter what its source. Though founded on sound physiological and anatomical facts and though on many occasions clinical demonstrations of its effectiveness have been made, practitioners generally are uninformed as to the possibilities of cordotomy. Inoperable pelvic carcinoma is one of the common causes of intractable pain and the speaker ventured to say of the specialists in urology and gynecology that few know what relief the operation would afford their patients.

The indication for the operation is clear enough—insufferable pain—but it is well to keep the patient under observation a few days in order to make sure that the pain is intense enough to justify a formidable operation.

From his own experience he is convinced that cordotomy is the most humane of all operations. Morphine is not the solution of the situation. Ever-increasing doses eventually fail to give relief, digestion is upset, sleep impossible and the patient generally demoralized. He remembers so well the comment of a patient after the operation, with an expectation of life of not over six months, "This is heaven."

As with all new operations, the technic will be modified from time to time. Originally Doctor Frazier designed special hooks to guide the operator in determining how deep to cut. These hooks are still useful in fixing the cord as the section is made, but since he has been making the section with the patient conscious, the depth of section can be determined by testing the patient. And he has found it an excellent plan to give the patient a rehearsal for several days prior to the operation of how he shall be expected to respond when tested for pain and temperature sense. Too much stress cannot be laid on this innovation. By cutting cautiously from without inwards in the conscious patient one can cut the tracts for tactile and conserve those for temperature sense. This is a delicate refinement that was not contemplated in the early days of the operation.

There is no doubt the operation has come to stay and should be given greater publicity. It is practised all too seldom. To be able to relieve pain of such intensity without damage to the other cord tracts is a real surgical accomplishment.

## BRIEF COMMUNICATIONS

### A MUSCLE-SPLITTING INCISION FOR POSTERIOR RESECTION OF THE UPPER THREE RIBS

A MUSCLE-SPLITTING incision for the posterior resection of the upper three ribs is described. It extends from the first dorsal spine to approximately the mid-portion of the spine of the scapula. The fibres of the trapezius muscle are separated and retracted, thus exposing the superior rhomboid and levator scapulae muscles. These muscles are separated and retracted, giving an excellent exposure of the upper two ribs so that as great a length of these

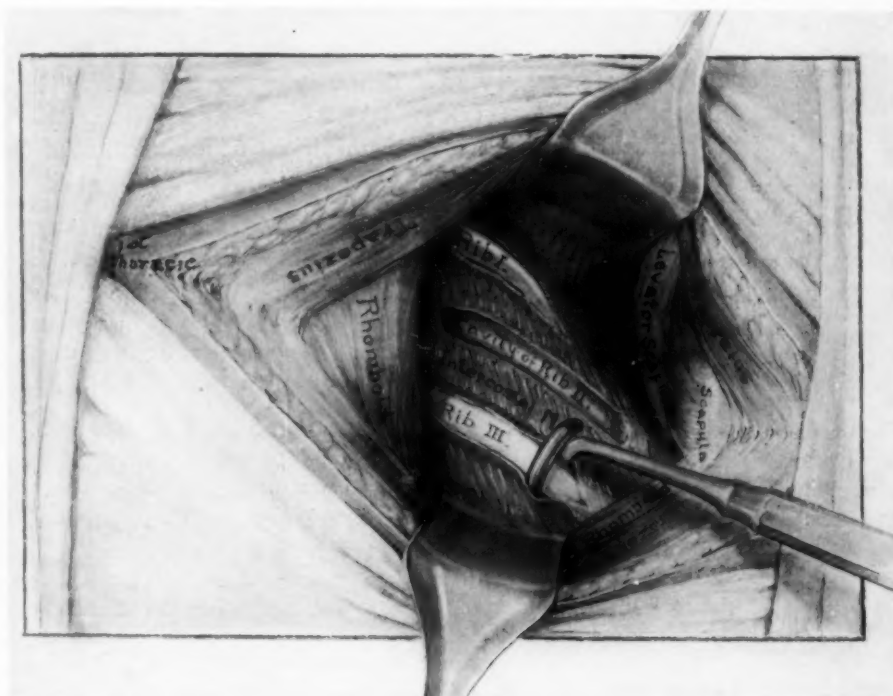


FIG. 1.—Incision for exposure of the upper three ribs, showing separation of the levator scapulae and superior rhomboid muscles.

ribs as desired can be removed. The exposure of the third rib is less adequate but sufficient to allow it to be resected lateral to its angle. An additional segment can easily be removed from this rib at the second stage. There is usually little blood lost in the operation and the nerve to the superior rhomboid muscle is easily preserved.

This incision was first used in April, 1928, and has been used in eleven cases since that time. It has been used only in cases which were considered poor surgical risks, where resection of more than three ribs at the first stage



## BRIEF COMMUNICATIONS

was considered unwise. Section of the heavy muscles over the upper portion of the shoulder with the resulting hæmorrhage and post-operative discomfort is avoided.

Head<sup>1</sup> has described an incision which differs from this one only in that he separates the fibres of the superior rhomboid instead of going between the superior rhomboid and levator scapulæ. Since the superior rhomboid is a short muscle, the exposure obtained by separating its fibres is quite limited. By going between the two muscles a better exposure of the first two ribs can be obtained.

ISAAC A. BIGGER, M.D., Nashville, Tenn.

*From the Department of Surgery of Vanderbilt University School of Medicine.*

## TRAUMATIC INGUINAL HERNIA\*

TRUE traumatic hernia is very rare and only a few cases have been reported in the literature. This hernia is due to an injury that tears the tissues, either by a crushing blow, a fall from a height or a laceration of the structures by a sharp instrument.

Z. O., a white male of nineteen, a chauffeur by occupation, was admitted to the Fourth Surgical Service of Bellevue Hospital September 15, 1929, suffering from pain and swelling in the right groin. The same day while riding a motorcycle he had been struck by an automobile and thrown about five feet, striking his right groin against the handlebar. Past history was negative. He had never been injured in any way nor had he had any complaint relative to the right groin.

Physical examination showed a well-developed, well-nourished, young adult male. Examination was negative except for the right groin where there were pain and tenderness on slight pressure; there were redness and a slight bulging of the right groin over the internal inguinal ring, with muscular spasm. The bulge increased on coughing.

A diagnosis of right indirect inguinal hernia of the occupational, industrial, or accidental type was made, it being thought that the hernial sac was present from birth and made evident by the motorcycle accident. An icebag was applied to the right groin and the patient confined to bed for three days. At that time there were no skin redness, no break in the skin surface, and no pain.

On September 18, 1929, he was operated upon for inguinal hernia under spinal anaesthesia. The operation chart reads as follows:

The customary inguinal incision was made. On reaching the aponeurosis of the external oblique muscle, the aponeurosis was found to be split through the external ring parallel to the fibres and running obliquely lateral for five inches over the internal ring. The split was traumatic and not congenital. There was considerable free serum and blood. At the internal ring there was a two-inch transverse tear of the internal oblique and transversalis muscles, the ring thus being destroyed. At the internal ring lateral to the inferior epigastric artery was a bulge of peritoneum more marked when the patient coughed. The cremasteric fascia was incised and no evidence of an indirect hernial sac

<sup>1</sup> Arch. Surg., vol. xvi, p. 1075, May, 1928.

\* Read before the Surgical Section of the New York Academy of Medicine, April 4, 1930.

## PERSISTING OBLITERATED OMPHALO-ENTERIC DUCT

found. The hernial sac was not opened. The lacerated muscles were sutured with No. 2 chromic catgut, the cord transplanted and a typical Bassini repair performed using No. 2 chromic catgut double continuous. Black silk to the skin. No drainage. The patient made an uneventful recovery and was discharged on the thirteenth post-operative day. Fortunately, no infection occurred in the traumatized tissues. He has been seen twice since discharge and shows no evidence of hernia and is symptom-free.

A traumatic hernia is subject to the following conditions:

- (1) The relationship between the accident and the hernia must be proved by an examination made within forty-eight hours.
- (2) It must be proved that the hernia appeared suddenly.
- (3) It must appear immediately after the accident and be accompanied by pain.
- (4) Proof must be furnished that the hernia did not exist prior to the accident.

In the case presented all the above conditions are fulfilled.

This case illustrates the fact that considerable damage may occur to tissues without commensurate skin damage.

Furthermore, in similar cases it would be wiser to defer surgery for several weeks until tissue vitality is restored.

Thanks are due to Dr. Carl B. Burdick, Director of the Fourth Surgical Division of Bellevue Hospital, for his courtesy in allowing this case to be presented.

EDWARD V. DENNEEN, M.D.

*New York, N. Y.*

## PERSISTING OBLITERATED OMPHALO-ENTERIC DUCT WITH MECKEL'S DIVERTICULUM AS A CAUSE OF ACUTE INTESTINAL OBSTRUCTION

CASES of bowel obstruction by a persisting cord-like remnant of the omphalo-enteric duct, while by no means rare in the literature, are sufficiently uncommon in the clinical experience of the average general surgeon to warrant, I believe, a brief description of the condition, and the recording of two additional cases.

The ductus-omphalo-entericus, during the first three weeks of embryonic development, connects the lumen of the intestine with the yolk sac (in man a structure comparable to the yolk sac: a "yolkless" yolk sac). Normally, this communication becomes obliterated by the end of the second month; somewhat later, the cord, representing the obliterated duct, disappears. In 2 per cent. of cases it remains patent at the proximal end as the well-known Meckel's diverticulum. In a decidedly smaller number of cases the duct will persist as an obliterated cord running from the fundus or the side of a Meckel's diverticulum to the umbilicus. In comparatively rare instances this cord will become freed from its umbilical attachment and either float free in

## BRIEF COMMUNICATIONS

the abdominal cavity or more commonly become attached elsewhere in the abdomen.

It is by this last-named variety, according to Treves, that constriction of the bowel is most often effected. "Certainly," he says, "in nearly all reported instances of strangulation under a diverticulum, the process has been adherent to a point other than the vicinity of the umbilicus."

Both cases I am herein reporting fall into this last category. It is interesting that both of these cases were referred by the same physician, Dr. D. Staneff, within a period of less than two months.

CASE I.—Miss L. G., aged twenty-two, entered the hospital on March 28, 1930, complaining of abdominal pain and vomiting. The pain began the previous evening, was cramp-like and intermittent in character, beginning in the region of the umbilicus, but seemed later to change to the lower left quadrant of the abdomen. She vomited

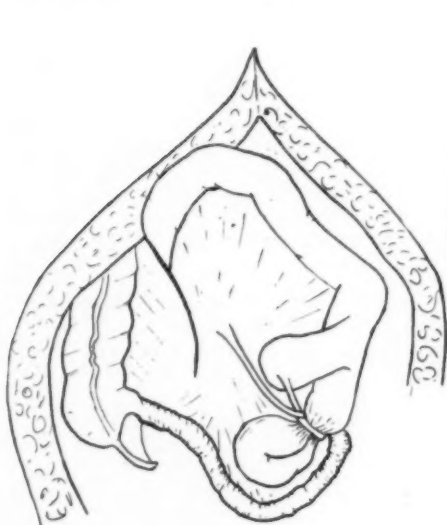


FIG. 1.—Case I. Intestinal obstruction from persistent obliterated omphalo-enteric duct.

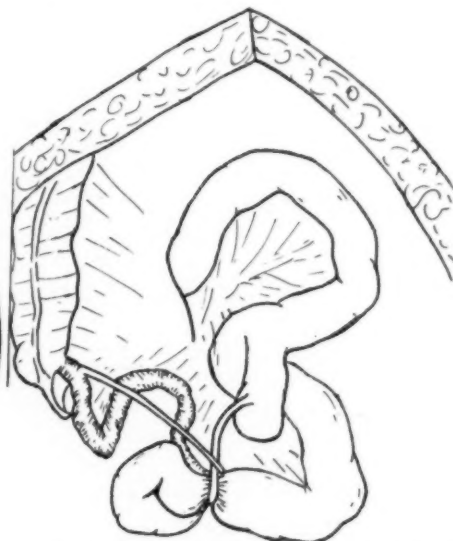


FIG. 2.—Case II. Intestinal obstruction from persistent obliterated omphalo-enteric duct.

frequently from the onset. On admission, her temperature was 100°, pulse 96, respirations 24, the white blood-cell count was 12,400, and the urine was entirely negative. There had been no movement of the bowels and no flatus expelled since the onset.

Examination revealed a well-developed white female, seemingly in severe pain of a paroxysmal type. Her color was good and she did not appear acutely ill. There was no definite rigidity of the abdominal muscles, though some resistance below the navel was evident. Tenderness and resistance were most marked in the lower left quadrant. There was a slight bloody vaginal discharge (her regular menstrual period had begun four days previously). Rectal examination revealed no definite mass in the pelvis and the uterus seemed normal. A small clear water enema was given which returned clear, with no flatus.

The abdomen was opened without further delay, revealing markedly distended coils of small intestine. These were followed systematically in the usual way to a point over the promontory of the sacrum and a little to the left. Here a loop of small intestine was found totally obstructed in a "snare" formed by a round smooth cord looped on

## PERSISTING OBLITERATED OMPHALO-ENTERIC DUCT

itself; the intestine beyond was collapsed. Severing this cord freed the obstruction. It was then found to run from the lateral surface of a Meckel's diverticulum to a point at the root of the small bowel mesentery where it was firmly adherent. I have tried to represent this in a semi-diagrammatic drawing (Fig. 1).

Dr. E. R. Long, of the Department of Pathology of the University of Chicago, returned the following pathological report:

"The specimen has the typical shape of a Meckel's diverticulum. The distal end is thickened, and a thin cord of tissue extends from it (apparently the remains of the omphalo-mesenteric duct). *Microscopic*.—The mucosa is normal except for some infiltration of eosinophiles. The submucosa is thickened by fibrosis and œdema."

This patient made an uneventful recovery and is symptom-free at the time of this writing.

CASE II.—Mr. P. O., aged fifty-six, a laborer. Obstruction symptoms had been present for four full days before a physician was called. Fæcal vomiting was already present on admission to the hospital, May 27, 1930. He was operated upon shortly after admission and died on the following day.

The findings were similar to those in Case I, with the exception that while in Case I the cord-like structure causing the obstruction extended from a Meckel's diverticulum to attach at the root of the mesentery of the small intestine, in this case (see Fig. 2) the distal end had become freed from its umbilical attachment and had fastened itself to the anti-mesenteric surface of the ileum at a point about two centimetres from the ileo-cæcal juncture. The mechanics of the strangulation in each case were those described by Treves as "obstruction by snaring."

The pathological report returned by Dr. Paul R. Cannon, of the Department of Pathology of the University of Chicago, follows: "The specimen consists of a Meckel's diverticulum and a fibrous cord about two millimetres in diameter. Sections through the diverticulum show œdema of the wall and infiltration by polymorphonuclear leucocytes. A cross-section of the fibrous cord shows a large, thick-walled artery and a smaller vein. The wall of the artery is hyalinized and greatly thickened. Around the vessels is a fibrous connective tissue, but no duct is present.

*Diagnosis*.—Meckel's diverticulum, showing acute enteritis; obliterated omphalo-mesenteric duct.

## BIBLIOGRAPHY

- Barron, Moses: Abnormalities Resulting from the Remains of the Omphalo-mesenteric Duct. *Surg., Gynec., and Obstet.*, vol. xxx, p. 350, April, 1920.
- Dietsel, F.: Ein Fall von Dottergangfistel. *Deutsch. Ztschr. f. Chir.*, Leipzig, vol. cci, pp. 266-269, 1927.
- Most, A.: Offener Ductus-omphalo-entericus und Nabelschnurbruch. *Beitr. z. Klin. Chir.*, Berlin, vol. cxliv, pp. 236-240, 1928.
- O'Neil, William Edward: Persistent Patent Omphalo-mesenteric Duct (Evanston Hospital). *Surgical Clin.*, vol. iii, p. 541, June, 1919.
- Ortenberg, H., v.: Zur Kasuistik Seltener Ileusfalle. *Medizinische Klinik*, Berlin, vol. xviii, pp. 178-179, February 5, 1922. (From the Clinic Santa Cruz, Rio Grande do sul, Brazil.)
- Terbruggen, A.: Strangulation Ileus Due to Persistence of the Omphalo-mesenteric Duct (Meckel's Diverticulum). *Zentralblatt für Chirurgie*, vol. lvi, pp. 1805-1806, July 20, 1929.
- Treves, F.: Intestinal Obstruction, Its Varieties, etc. Cassell and Co., chap. III, Sect. 3, Strangulation by Meckel's Diverticulum, pp. 31-44, incl., 1884.

GUY S. VAN ALSTYNE, M.D.  
Chicago, Ill.

## RECOVERY FROM FRACTURE OF THE NECK OF THE FEMUR IN A NONAGENARIAN \*

THE abduction method of treatment of fracture of the neck of the femur described by Whitman is so widely accepted as the best non-operative procedure that further contributions may seem quite unnecessary. But a few years ago the restoration of form and function in such cases was taught as an object rarely to be expected or even sought. The danger to life in weak and aged patients was considered such as to forbid the treatment in the plaster case.

The opportunities to observe and record the results of active treatment of this condition in patients over ninety years of age are rare indeed. According to the American experience tables of mortality for persons ninety-three years of age there were records of seventy-nine persons and of these fifty-eight died during the year giving a death rate of seven hundred thirty-four per thousand and an average expectancy of nine and one-half months. This brief expectancy may raise an economic question but one who has observed the immediate relief from suffering which occurs when the fracture is properly reduced and treated by the abduction method is apt to become an advocate of the treatment in the most hopeless cases. The case I now report is that of a ninety-three-year-old woman who was treated by the artificial impaction method of Cotton with Whitman abduction in a plaster case.

Mrs. A. B., ninety-three years of age in August, 1928, while entering a store through a revolving door stumbled and fell to the floor November 23, 1928. When I saw her immediately thereafter she was sitting in a chair unable to use the left lower extremity and complaining of pain in the left hip region. She was immediately placed in an ambulance and taken to the Asbury Hospital. She weighed about eighty-five pounds. She appeared very old and frail. Her eyesight was very much diminished. There was a large adenomatous goitre present. Blood pressure was one hundred thirty systolic and eighty diastolic. The urine was normal. The physical examination was otherwise normal. The past history was not important. The röntgenogram showed an intracapsular fracture of the neck of the left femur with the distal fragment displaced upward about one inch and rotated outward. (Fig. 1.)

Treatment for the first four days consisted of rest in bed with the extremity supported as well as possible with sandbags on each side of the thigh and leg. During this time she suffered a great deal of pain and was very difficult to care for, but she rallied from the shock and presented a somewhat encouraging appearance. On the fourth day she was taken to the operating room and placed on a Hawley table and given a general anæsthetic and the fracture was reduced in the usual manner. In order to be certain that the fracture was reduced before instituting further treatment a portable X-ray machine was moved into the operating room and an exposure was made showing the fractured bones in perfect position. (Fig. 2.) Felt pads were then placed over the greater trochanter and an artificial impaction was performed according to the method of Cotton. A plaster case was then applied from the nipple line to the toes with the limb in abduction and internal rotation. Fig. 3 shows the position in the plaster case and illustrates the impaction when compared with Fig. 2.

---

\* From the University of Minnesota Medical School.





Fig. 1.—Röntgenogram of ninety-three-year-old woman taken on day of injury showing intracapsular fracture of the neck of the left femur with the distal fragment displaced upward about one inch and rotated outward as indicated by the prominence of the lesser trochanter.



Fig. 2.—Röntgenogram taken with portable apparatus while patient is under general anesthesia on Hawley fracture table after reduction of the intracapsular fracture but before artificial impaction has been performed. Note the perfect apposition of the fragments and the inversion of the femur as evidenced by the almost complete disappearance of the lesser trochanter.



Fig. 3.—Röntgenogram taken four months after injury and one month after removal of the plaster case. Note the absence of absorption of the femoral neck. The femur is in the position of abduction. Note the normal position of the lesser trochanter.

## BRIEF COMMUNICATIONS

Immediately upon recovery from the anæsthetic she remarked upon the absence of pain in the hip and continued to speak of the absence of pain in the hip to all visitors. The usual after care was given consisting of turning her over on her abdomen for one hour three times daily and raising the head of her bed and later getting her about in the case in a wheel chair.

One month after injury she developed a slight respiratory infection and began to eat very poorly and her blood pressure dropped from one hundred thirty systolic to one hundred in a few days. She was given a daily eggnog containing one half ounce of brandy during the next two months and her progress was thereafter uneventful.

The plaster case was removed February 26, 1929, three months after injury. She was kept in bed for an additional month. At the end of four months röntgenograms taken in abduction and adduction (Fig. 3) showed that the fracture was in perfect position and the head rotated with the neck of the femur.

She was supplied with a walking caliper brace and crutches and was taught to walk a little and was returned to the home for the aged. During the next three months she was taken outside for daily fresh air and was encouraged as much as possible but she gradually failed and died seven months and one week after receiving the injury.

ROSCOE C. WEBB, M.D.  
*Minneapolis, Minn.*

## THE REHFUSS TUBE IN GASTRIC SURGERY

HAVING observed with what advantage Dr. J. M. T. Finney has employed the Rehfuß tube in gastroenterostomies, pyloroplasties and in Polya anastomoses following gastric resections, it has caused me to wonder why its use in such instances is not more popular. Therefore, an addition to the Rehfuß tube is here described, which allows for the method a degree of dependability, convenience and exactness not otherwise obtainable and in addition the comfort of the patient is in no manner compromised.

The method consists, briefly, of bringing the upper end of the Rehfuß tube out through the nose after the metal olive has been swallowed.

The use of the Rehfuß tube alone, as applied by Doctor Finney, is briefly as follows: After the special gastric pre-operative preparation of the patient a sterile regular Rehfuß tube is swallowed before the patient goes to the operating room. The end of the tube protruding from the mouth is fastened to side of cheek with adhesive. A final aspiration may be made to insure an empty stomach. If on opening the stomach at operation it is found to be filled with regurgitated or secreted fluid, an attendant may aspirate the stomach from above before the operator proceeds, thus maintaining a clean operating field. During the anastomosis the metal olive is pulled through the new stoma just before the anterior row of sutures is taken, and placed about ten centimetres into the distal loop of intestine forming the anastomosis.

The advantage of such a procedure in post-operative care is obvious. Murphy drip may be connected up to the Rehfuß tube at once and fluids begun, using a 10 to 20 per cent. glucose at the start and adding other liquid nourishment as soon as the patient will tolerate it. The intake of fluids and

## THE REHFUSS TUBE IN GASTRIC SURGERY

nourishment, in this manner, is deposited directly into the upper intestinal tract and beyond the site of anastomosis, thus sparing the stomach and anastomosis site of digestive functions. Adequate fluids and nourishment are absorbed in the normal physiological manner and in the great majority of instances the patient is spared all intravenous therapy, which is especially advantageous in eliminating the added trauma from repeated use of the

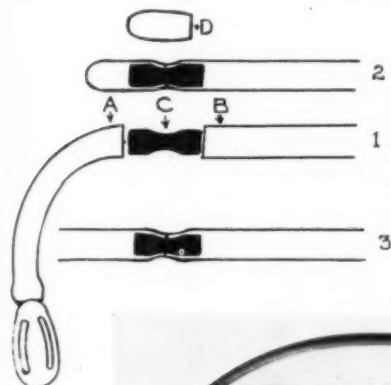


FIG. 1.—Diagram showing the four parts of the apparatus in the various combinations used in the procedure. A—Rehfuß duodenal tube. B—Rubber tubing, same as in Rehfuß tube. C—Solid metal connection. D—Rubber tip, closed at one end. Same size as tubing. (1) All parts disconnected. (2) B, C, D assembled to introduce through nose. A has been swallowed so that metal olive is in stomach. (3) Rubber tip removed from 2; A connected; ready to be pulled through nose.

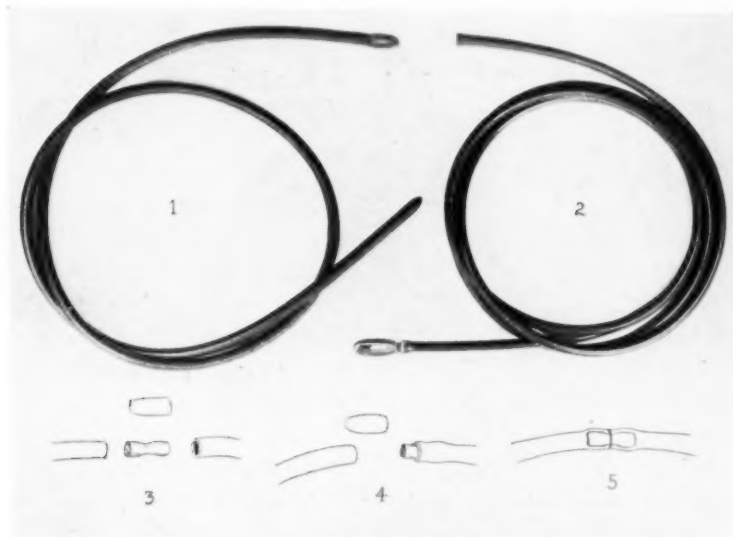


FIG. 2.—(1) Nasal tube with rubber tip attached to the metal connection, as represented in 2 of FIG. 1, ready for insertion through nose. (2) Rehfuß tube. (3) The ends of both tubes, the metal connection, and rubber tip disassembled, showing all the parts of the apparatus. (4) Rubber tip removed after end of nasal tube has been pulled out from pharynx through mouth. (5) End of Rehfuß tube attached to nasal tube, ready to be drawn through nose.

hypodermoclysis and vena puncture needle after an operation accompanied by more or less surgical shock.

Should excessive and irritating fluids accumulate in the remainder of the stomach or anastomosed loop of jejunum, these may be aspirated through the tube at any time post-operative.

The one objection with the Rehfuß tube alone is that it must protrude from the mouth, which is uncomfortable and a source of annoyance for the several days that it is desirable to keep the tube in place. Also, the tube

# BRIEF COMMUNICATIONS

may be easily pulled out of the stomach unconsciously by the play of the patient's tongue upon it or accidentally by attendants prior to or after operation. Unable to find a suitable contrivance on the market that would allow one to bring the upper end of tube out through the nose, a simple apparatus

has been made by the Hamilton-Schmidt Surgical Company at my suggestion which is pictured and described herewith.

By this method of bringing the upper end of the tube out through the nose, it is anchored securely in its proper position by means of its passage through the nares and allows far more comfort to the patient. It is hoped that by this means the objections to the procedure will thus be eliminated and allow for its more popular and dependable use.

Referring to the diagram of Fig. 1, the metal olive and tube of the Rehfuß tube, A, are swallowed by the patient until the proper length has passed into the œsophagus to permit the olive to lie in the stomach. The assembled tube, 2, is then passed into nose and the tip is grasped by a pair of forceps in the pharynx and pulled through the mouth. The rubber tip, D, is removed and the free end of A is attached to the metal connection, making a smooth continuity of tubing. Unit 3 is then pulled out through the nose until the Rehfuß tube passes directly



FIG. 3.—(1) Shows the Rehfuß tube in place. The nasal tube, with its special tip as described, has been passed into the pharynx. From here it has been pulled out through the mouth by grasping it with a hæmostat while depressing the tongue. Then the tip is removed as in 4 of FIG. 2 and the two ends joined as in 5 of FIG. 2. Then the upper end of the nasal tube is pulled out until the end of the Rehfuß tube protrudes from the nose. All parts are then disconnected and we have ready for use a Rehfuß tube passing through the nose with the metal olive lying in the stomach. (2) Shows the end of Rehfuß tube with metal olive pulled through the anastomosis opening and placed well within the distal loop of anastomosed intestine before anterior row of sutures is taken.

from œsophagus, through pharynx, and out the nose. Then all accessory parts are removed, leaving the free end of the Rehfuß tube protruding from the nose, in which position it is allowed to remain until its removal.

Removal is easily accomplished by grasping the portion of tube in the pharynx with a forceps and pulling both the nasal and œsophageal portions of tube out through the mouth by one procedure.

ROLAND W. STUEBNER, M.D.

St. Louis, Mo.

From the Department of Surgery, Washington University.

## MEMOIRS

HENRY BEECKMAN DELATOUR

1866-1930

HENRY BEECKMAN DELATOUR died August 23, 1930, in the American Hospital, in Paris. Having been taken ill while in Vichy, Austria, he was removed to the hospital in Paris, where, after an illness of three weeks,



HENRY BEECKMAN DELATOUR

he died in his sixty-fifth year, having been born in the city of New York, March 27, 1866.

He was educated in the humanities in the College of the City of New



## HENRY BEECKMAN DELATOUR

York and received his medical degree from the College of Physicians and Surgeons of Columbia University, in 1887. He was elected a Fellow of the American Surgical Association in 1910.

Immediately after his graduation in medicine in 1887, he was appointed an interne in the Seney-Methodist Hospital in Brooklyn, which was then being organized. He was, thus, the first house surgeon of that hospital, to which he gave enthusiastic work in the organization of the active and progressive surgical service which characterized it. Shortly after the completion of his internship, a vacancy having occurred in the position of Assistant Surgeon to the hospital in the service of Dr. George R. Fowler, Doctor Delatour was appointed to fill the vacancy, and at once entered upon independent active and important surgical work which ended only with his death, over forty years later. In 1891, upon the organization of the Norwegian Hospital in Brooklyn, he was appointed one of the attending surgeons of that institution and continued to labor there up to the time of his death. In 1896, he was appointed one of the attending surgeons at St. John's Hospital, to which institution he also continued to give service throughout the remainder of his life. During later years his activities were especially devoted to promoting the welfare of St. John's Hospital, in which he not only filled the important positions of Chief of Staff and Senior Attending Surgeon, but was also a member of the board of managers, in the Executive and Building Committees of which he was very active, and more particularly during the development of plans for a new hospital, his experience, his labors and his studies made his advice invaluable. His surgical activities were not confined to the hospitals already mentioned; he also served as the head of the surgical staff of the Jewish Hospital from 1906 to 1912, and to the Long Island College Hospital during the period between 1896 and 1906 he was an attending surgeon and clinical professor of surgery. During the World War, Doctor Delatour held the rank of major in the Medical Reserve Corps and was in charge of the surgical service at Camp Upton. From 1904 to 1912 he was chief of the ambulance service of the city of Brooklyn.

In 1895 he married Miss Jeannie May Peck, of Brooklyn. There were no children from this union. His residence and private office were at 75 Eighth Avenue, Brooklyn.

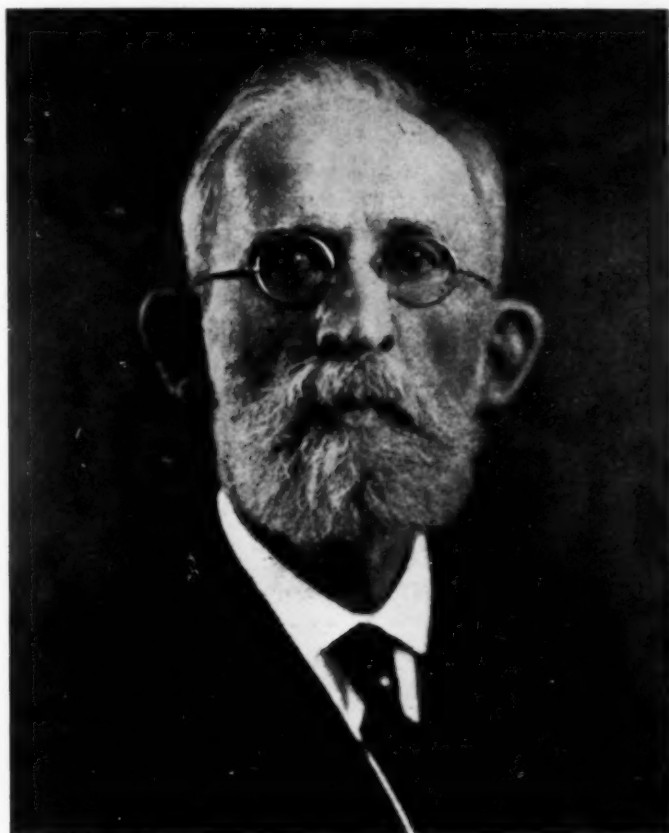
Doctor Delatour was, above all, a clinician. His judgment, his talents and his ambitions were devoted to relief of the actual suffering which came within his personal view. His energies were so fully occupied by this practical work that no time was left for the research laboratory or for the literary labors of authorship. His personality was most pleasing. No one came in contact with him without being impressed by his genuineness, the solidity and scope of his attainments and the enterprise and capacity of his labors.

L. S. P.

## ALBERT VANDER VEER

1841-1930

ALBERT VANDER VEER, of Albany, New York, was born in Root, Montgomery County, New York, July 10, 1841, the son of Abraham H. Vander Veer and Sarah Martin, his wife. The Vander Veer family in America traces its origin to Cornelise Janse Vander Veer, who emigrated



ALBERT VANDER VEER

from Alkmaar, Holland, in February, 1659, and settled on Long Island. The Revolutionary battle of Long Island of 1776 was partly fought on the Vander Veer farm. Members of the family moved from Long Island to New Jersey and from there in 1783 Jacob Vander Veer moved to the Mohawk Valley. His descendant, Albert, the subject of this sketch, after receiving his earlier education in the public schools of his vicinity, entered the Albany Medical College in 1861. Later, he transferred to the Medical Department of Colum-

## ALBERT VANDER VEER

bia University in Washington, D. C., from which institution he was graduated in January, 1863.

In the early part of the Civil War, in May, 1862, he was appointed a Medical Cadet in the Medical Corps of the United States Army and was assigned to a hospital in Washington which enabled him to continue his medical studies at the Columbia University as already stated. In December, 1862, he was commissioned Assistant Surgeon of the 66th New York Volunteers. His subsequent military record up to the close of the war was a distinguished one. In June, 1864, he was promoted to be Surgeon with the rank of Major and appointed one of the operating surgeons of the First Division of the Second Army Corps. He remained with the First Division in all its battles after the first Fredericksburg to the surrender of Appomattox. He was mustered out of the service in September, 1865.

His return to civil life was followed by post-graduate work in New York City and in Europe. He received the honorary degree of M.D. from the Albany Medical College in 1869; the degree of A.M. from Williams College in 1882; the degree of LL.D. from George Washington University in 1904.

Doctor Vander Veer had many medical, business and social connections. He was an ex-president of the American Medical Association and of the American Surgical Association. He was a member of the Loyal Legion and of the Grand Army of the Republic. From 1895 to the date of his death, in 1930, he was a member of the Board of Regents of the University of the State of New York of which he became the Chancellor in 1921. In 1868 Doctor Vander Veer was appointed an Attending Surgeon of the Albany Hospital of which institution he was made Surgeon-in-Chief in 1904. He was professor of anatomy in the Albany Medical College from 1877 to 1882; professor of surgery from 1882 to 1914.

Doctor Vander Veer became a resident of Albany in 1860 and practiced medicine and surgery in that city for over fifty years. He was generally recognized as one of the most distinguished members of the medical profession in the State of New York. He left two sons, Edgar Albert and James Newell, both of whom continue the work of their father in surgery and occupy conspicuous positions in their profession.

### EDITORIAL ADDRESS

The office of the Editor of the *Annals of Surgery* is located at 115 Cambridge Place, Brooklyn, New York. All contributions for publication, Books for Review, and Exchanges should be sent to this address.

Remittances for Subscriptions and Advertising and all business communications should be addressed to the

### ANNALS OF SURGERY

227-231 South Sixth Street  
Philadelphia, Penna.

## INDEX FOR VOLUME XCII

### A

- Abdominal Metastasis of Thyroid Tissue, 1031.  
Abscess, Subphrenic, Transpleural, Operation for, 477.  
ALEXANDER, EMORY G.: Skin Ulceration, 784.  
Alkalosis Simulating Uræmia, 900.  
ALLEN, ARTHUR W.: Circulatory Disturbances of Extremities, 931.  
American Surgical Association; Semi-centennial, 481, 801.  
Amniotic Fluid, Prevention of Peritoneal Adhesions by, 281.  
Anæsthesia, Ether, Brain Calcium in, 993; Splanchnic, in Ileus, 721.  
Anal Sphincter, Reconstruction of, 152.  
ANDREWS, EDMUND: Brain Calcium in Ether Anæsthesia, 993; Post-operative Blood Chemistry, 786.  
Aneurism of the Subclavian Artery, 458.  
ANTUPIT, LOUIS: Intestinal Obstruction, 270.  
Anus, Imperforate, 77.  
Appendicitis, Ileocaecal Obstruction with, 728.  
ARCHIBALD, EDWARD W.: Gall-bladder Surgery, 662.  
Arm, Melanocarcinoma of the, 117.  
Artery, Subclavian, Aneurism of the, 458.  
Arthritis, Chronic, Showing Improvement Following Lumbar Sympathectomy, 306.  
Arthrotomy of Knee-joint for Hypertrophic Osteoarthritis, 309.  
ASHHURST, ASTLEY P. C.: Osteoperiosteal Bone Grafts, 300.  
Aspiration, Biopsy by Needle Puncture and, 169.  
Atelectasis, Post-operative Pulmonary, 801.  
AUCHINCLOSS, HUGH: Bilateral Subcutaneous Ruptured Quadriceps, 311.

### B

- Bacteræmia, Serum Treatment of, 910.  
BALFOUR, DONALD CHURCH: Alkalosis Simulating Uræmia, 909; Results of Gastro-enterostomy for Ulcer, 558.  
BALLIN, MAX: Skin Ulceration, 784.

- BANCROFT, FREDERICK W.: Bone Graft, 315; Gall-bladder Surgery, 662; The Surgical Treatment of Urinary Incontinence in Women, 471.  
Barbiturate Sodium Iso-amylethyl, and Spinal Anæsthesia, 472.  
BAZIN, ALFRED T.: Papilloma of Common Bile Duct, 658.  
BECK, CLAUDE S.: Chordotomy for Intractable Pelvic Pain, 335.  
Bedsore, Insulin in the Treatment of Non-Diabetic, 318.  
BEER, EDWIN: Diseases of the Urinary Tract in Children, Review of, 320; Uroselectan Intravenous Urography, 761.  
BERG, ALBERT A.: Mortality and Late Results of Subtotal Gastrectomy for the Radical Cure of Gastric and Duodenal Ulcer, 340.  
BEVAN, ARTHUR DEAN: Anatomy and Operative Technic of Sliding Hernias, 754, 759.  
BIGGER, ISAAC A.: Muscle-splitting Incision for Posterior Resection of Upper Three Ribs, 1107.  
Bile Duct, Common, Congenital Cyst of, 158; Papilloma of, 658; Intrahepatic, Changes, 141; Removal of Rubber Tube from, 1096.  
Biliary Fistulæ after Cholecystectomy, 649.  
Biopsy by Needle Puncture and Aspiration, 169.  
BLAIR, VILRAY P.: Surgery of Tumors, 690; Tendon Strips in Facial Paralysis, 694.  
Blastomycetic Osteomyelitis of Femur, 1100.  
Blood Chemistry, Post-operative, 786, 993.  
BLOODGOOD, JOSEPH C.: Operative Results for Stomach Cancer, 574.  
Bone Grafts, Osteoperiosteal, 161.  
Bone of Forearm, Necrosis of, 1099.  
BOTHE, ALBERT E.: Pathological Study of Posterior Vesical Neck Obstruction, 294.  
BOTHE, F. A.: Ileocaecal Obstruction with Appendicitis, 728.  
Bowel Carcinoma, 130.  
Brachial Plexus, Traumatic Lesions of the, 182, 302.

## INDEX

- Brain Calcium in Ether Anæsthesia, 993.  
 Breast, Sarcoma of, 1059.  
 BRENIZER, ADDISON G.: Deformities and Obstructions of the Stomach and Duodenum, 367.  
 BRILL-SELLING: Post-operative Pulmonary Atelectasis, 801.  
 BRINES, OSBORNE ALLEN: Annular Pancreas Involved in Acute Hæmorrhagic Pancreatitis, 241.  
 Bronchus, Primary, Rupture of, 154.  
 BROWN, ALFRED: Influence of Hyperthyroidism upon the Secretion of Free Hydrochloric Acid, 321.  
 BRUCE, HERBERT A.: Sulphuric Acid Pyloric Occlusion, 897.  
 BRUNN, HAROLD: Post-operative Pulmonary Atelectasis, 801.  
 Buccal Mucosa, Cancer of, 681; and Upper and Lower Lips, Melanocarcinoma of, 118.  
 BURDEN, VERNE G.: Partial Resection of Pyloric Sphincter, 533.  
 BURDICK, CARL GOODWIN: Hare-lip and Cleft Palate, 35.  
 BUZBY, BENJAMIN F.: Blastomycetic Osteomyelitis of Femur, 1100; Brachial Plexus Injury, 302.
- ### C
- CABOT, HUGH: Coccus Infections of the Kidney, 766.  
 Calcium, Brain, in Ether Anæsthesia, 993.  
 CALLENDER, GEORGE R.: Neurofibroma Pericardial Pleura, 666.  
 Cancer of Buccal Mucosa, 681; of Stomach, Long-lasting Post-operative Benefit, 540; of Stomach, Operative Results for, 574.  
 Carcinoma of Bowel, 130; of Rectum, 309; of Sigmoid, Recurrent, 470.  
 Cardiac Arrest, 331.  
 CATTELL, RICHARD B.: Thyroglossal Cysts and Sinuses, 57.  
 Chemistry, Blood, Post-operative, 786, 993.  
 Chest Wall, Depressed Fracture of, with Hernia of Lung, 312.  
 Children, Acute Ulcerations of the Stomach in, 234; Diseases of the Urinary Tract in, Review of Beer and Hyman on, 320.  
 CHITTENDEN, ARTHUR S.: Reconstruction of Anal Sphincter, 152.  
 Cholecystectomy, Biliary Fistulæ after, 649; End-results in 500 Cases of, 376.  
 Cholecystitis, Acute, 644.  
 Cholelithiasis, Intrahepatic, 1093.  
 Cholesteatoma, 123.  
 Chondrodysplasia, Deforming, 92.  
 Chordotomy for Intractable Pelvic Pain, 335.  
 Circulatory Disturbances of Extremities, 931.  
 Cleft Palate and Hare-lip, 35.  
 CLOUD, ALBERT W.: Malignant Tumors and Their Metastases, 434.  
 CLURMAN, MORRIS J.: Inflammation of Meckel's Diverticulum, 388.  
 CLUTE, HOWARD M.: Thyroglossal Cysts and Sinuses, 57.  
 Coccus Kidney Infections, 766.  
 CODMAN, ERNEST A.: Surgery of Tumors, 679.  
 COLEY, WILLIAM B.: Surgery of Tumors, 691.  
 COLP, RALPH: Acute Deferentitis with Abscess Formation, 457; Aneurism of the Subclavian Artery, 458; Echinococcus Cyst of the Liver, 461.  
 Cordotomy, 998.  
 Coronary Occlusion, Post-operative, 1014.  
 CROSSAN, EDWARD T.: Lymph Exudate and Fibrous Tissue, 1019.  
 CUNNINGHAM, WILLIAM F.: Carcinoma of Rectum, 309; Consecutive Perforations of Stomach and of Duodenum, 308; Operative Stricture of the Common Duct: Duodenal Fistula, 470.  
 Cyst, Congenital, of Common Bile Duct, 158; Echinococcus, of the Liver, 461; Parovarian Dermoid, 159; of the Spleen, 67; Thyroglossal, and Sinuses, 57.
- ### D
- D'AUNOY, RIGNEY: Sarcoma of Breast, 1059.  
 DAVID, VERNON C.: Splanchnic Anæsthesia in Ileus, 721.  
 DAVIS, DAVID M.: Surgical Treatment of Genital Elephantiasis in the Male, 400.  
 Death, Causes of Post-operative, 1.  
 DEAVEY, JOHN B.: Partial Resection of Pyloric Sphincter, 533.  
 Deferentitis, Acute, with Abscess Formation, 457.



# INDEX

- DEIBERT, IRVIN E.: Treatment of Osteomyelitis by "Orr" Method, 1087.
- DELATOUR, HENRY B.: Memoir of, 1117.
- DENGEL, L.: Plastic Restoration of Esophagus, 51.
- DENNEEN, EDWARD V.: Traumatic Inguinal Hernia, 1108.
- Dermoid Cyst, Parovarian, 159.
- Desmoid Tumors, 444.
- Diverticula of the Sigmoid, 739.
- Diverticulum, Meckel's, Inflammation of, 388.
- DOBZANIECKI, WLADYSLAW: Cysts of the Spleen, 67.
- DOEGE, KARL W.: Fibrosarcoma of Mediastinum, 955.
- DONOVAN, EDWARD J.: Torsion of the Spermatic Cord in Infancy, 405.
- DORRANCE, GEORGE M.: Necrosis of Bone of Forearm, 1099; Osteoperiosteal Bone Grafts, 161.
- Duct, Omphalo-enteric, Persisting Obliterated, 1109.
- Duodenal Fistula, Operative Stricture of the Common Duct, 467; Ulcer, Excision of, 563; Operative Mortality, 616; Operation Results, 620; Mortality and Late Results of Subtotal Gastrectomy for the Radical Cure of Gastric and, 340.
- Duodenal-gastric Ulcers, Operative Results, 545; Surgical Therapy for, 597.
- Duodenum, Consecutive Perforations of Stomach and of, 308; and Stomach, Deformities and Obstructions of the, 367.
- DWIGHT, KIRBY: Bone Graft, 315.
- E**
- Echinococcus Cyst of the Liver, 461, 466.
- Ectopic Spleen Causing Intestinal Obstruction, 263.
- EIMAN, JOHN: Serum Treatment of Bacteremia, 910.
- Elephantiasis in the Male, Surgical Treatment of Genital, 400.
- ELIASON, ELDRIDGE L.: Treatment of Osteomyelitis, 1104; Welch Bacillus Antitoxin in Intestinal Obstruction, 301.
- ELKIN, DAN COLLIER: Subphrenic Abscess, Transpleural Operation for, 477.
- ELLIS, EDWARD B.: Biopsy by Needle Puncture and Aspiration, 169.
- Embolism, Pulmonary, Trendelenburg's Operation for, 498.
- Empyema Thoracis, Acute, Treatment of, 212.
- Endothelial Tumors Arising from Synovial Membrane, Intra-articular, 421.
- Entero-anastomosis in Ileus, 704.
- ENZER, NORBERT: Krukenberg Tumors of the Ovary, 149.
- Epithelioma, Supra-orbital, 115.
- Ergosterol, Irradiated, in the Treatment of Fractures, Non-effect of, 415.
- Ether Anaesthesia, Brain Calcium in, 993.
- Exomphalos, 454.
- Exophthalmos, pulsating, 8.
- Exostoses, Multiple, or Hereditary Deforming Chondrodysplasia, 92.
- Extremities, Circulatory Disturbances of, 931.
- F**
- Facial-hypoglossal Nerve Crossing, 122.
- Facial Paralysis, Tendon Strips in, 694.
- FELTER, ROBERT K.: End-results of Inguinal Hernia Operations, 744; Surgery of Peptic Ulcer, 602.
- Femur, Blastomycetic Osteomyelitis of, 1100; Fractures, Neck of, 882; Fracture of Neck of, in Nonagenarian, 1112.
- FETTERMAN, JOS.: Orthopnea in Acute Ruptured Tubal Pregnancy, 473.
- Fibromyxoma, Retroperitoneal, 1067.
- Fibrosarcoma of Mediastinum, 955.
- Fibrous Tissue and Lymph Exudate, 1019.
- FINNEY, JOHN M. T.: Operation Results, Duodenal Ulcer, 620.
- Fistula, Biliary, after Cholecystectomy, 649; Duodenal, with Operative Stricture of the Common Duct, 467; Vesicovaginal, 774.
- Forearm, Necrosis of Bone of, 1099.
- Foreign Body in Heart, 1097.
- FOSTER, LEWIS CHANDLER: Treatment of Acute Empyema Thoracis, 212.
- Fracture of Chest Wall, Depressed, with Hernia of Lung, 312; of Neck of Femur in Nonagenarian, 1112.
- Fractures, Immobilization by Steel Skewers in, 147; Neck of Femur, 882; Non-effect of Irradiated Ergosterol in the Treatment of, 415; Open Operation in, 838.
- FRAZIER, CHARLES H.: Chronic Arthritis Showing Improvement Following Lumbar Sympathectomy, 306; Cordotomy, 1106.

## INDEX

FREEMAN, LEONARD: Post-operative Progressive Skin Ulceration, 779.

### G

- Gall-bladder, Contractile Function of the, 301; Philosophic Considerations of, 640.  
 Gasserian Ganglion, Penetrating to the, 984.  
 Gastrectomy for the Radical Cure of Gastric and Duodenal Ulcer, Mortality and Late Results of Subtotal, 340.  
 Gastric Hæmorrhages, Thrombophlebitic Splenomegaly with, 463; Surgery, Reh-fuss Tube in, 1114; Ulcer, a Bacteriological and Clinical Study of, 222.  
 Gastric and Duodenal Ulcer, Mortality and Late Results of Subtotal Gastrectomy for the Radical Cure of, 340; Operative Results, 545; Surgical Therapy for, 597.  
 Gastro-enterostomy for Ulcer, Results of, 558.  
 GATEWOOD, DOCTOR: Gall-bladder Surgery, 656; Results of Operations for Peptic Ulcer, 554.  
 GEDDIE, KENNETH B.: Hyperparathyroidism, 202.  
 Genital Elephantiasis in the Male, Surgical Treatment of, 400.  
 GESCHICKTER, CHARLES F.: Multiple Myeloma as a Single Lesion, 425; Surgery of Tumors, 677.  
 GIBBON, JOHN H.: Operative Mortality, Duodenal Ulcer, 616.  
 GIBSON, CHARLES L.: End-results of Inguinal Hernia Operations, 744.  
 GIBSON, THOMAS E.: Primary Closure in Prostatectomy, 82.  
 Gland Filtrate in Hodgkin's Disease, 23.  
 Grafts, Osteoperiosteal Bone, 161.  
 GRAHAM, JOSEPH B.: Rupture of Primary Bronchus, 154.  
 GRANGER, AMEDÉE: Röntgen Diagnosis of Ileus, 947.  
 GRANT, FRANCIS C.: Cordotomy, 998.  
 GRAVES, AMOS MAVERICK: Tetanus in New Orleans, 1075.  
 GREEN, THOMAS MEARS: Cardiac Arrest, 331.  
 GUERRY, LEGRAND: Hepatico-duodenostomy, 663.

### H

Hæmorrhages, Gastric, Thrombophlebitic Splenomegaly with, 463.

- Hæmorrhagic Pancreatitis, Acute, Annular Pancreas Involved in, 241.  
 HALE, KELLEY: Hereditary Deforming Chondrodysplasia or Multiple Exostoses, 92.  
 HANFORD, JOHN M.: Pulsating Exophthalmos, 8.  
 HANRAHAN, EDWARD M., JR.: Gland Filtrate in Hodgkin's Disease, 23; Operation Results, Duodenal Ulcer, 620.  
 Hare-lip and Cleft Palate, 35.  
 HART, DERYL: Tumors of Peripheral Nerves, 961.  
 HARTWELL, JOHN A.: Surgery of Peptic Ulcer, 602.  
 HAZELTINE, MATTHEW E.: Excision of Duodenal Ulcer, 563.  
 Heart, Foreign Body in, 1097.  
 Hepatico-duodenostomy, 663.  
 Hernia, Inguinal, Operations, End-results of, 744; of the Umbilical Cord (Exomphalos), 454; Sliding, Anatomy and Operative Technic of, 754; Traumatic Inguinal, 1109.  
 Hirschsprung's Disease, Sympathectomy for, 710.  
 Hodgkin's Disease, Gland Filtrate in, 23.  
 HORSLEY, J. SHELTON: Operative Results, Gastric-duodenal Ulcers, 545; Skin Ulceration, 783.  
 HORWITZ, ALEC: Hernia of the Umbilical Cord (Exomphalos), 454.  
 Hydrochloric Acid, Free, The Influence of Hyperthyroidism upon the Secretion of, 321.  
 HYMAN, ABRAHAM: Diseases of the Urinary Tract in Children, Review of, 320.  
 Hyperparathyroidism, 202.  
 Hyperthyroidism, Influence of, upon the Secretion of Free Hydrochloric Acid, 321.  
 Hypoglossal-facial Nerve Crossing, 122.

### I

- Ileocaecal Obstruction with Appendicitis, 728.  
 Ileus, Entero-anastomosis in, 704; Röntgen Diagnosis of, 947; Splanchnic Anæsthesia in, 721.  
 Incision, Muscle-splitting, for Posterior Resection of Upper Three Ribs, 1107.  
 Incontinence in Women, Urinary, Surgical Treatment of, 388.

## INDEX

- Infancy, Torsion of the Spermatic Cord in, 405.  
 Infections, Coccus Kidney, 766.  
 Infusions, Intravenous, Cause and Elimination of Reactions after, 195.  
 Inguinal Hernia, Operations, End-results of, 744; Traumatic, 1108.  
 Insulin in the Treatment of Non-Diabetic Bedsores, 318.  
 Intestinal Obstruction, 270; Ectopic Spleen Causing, 263; Use of Perfringens Antitoxin in, 277.  
 Intestines, Stomach and, Suturing, a Dependable Method for, 410.  
 Intra-articular Endothelial Tumors Arising from Synovial Membrane, 421.  
 Intrahepatic, Bile Duct Changes, 141; Cholelithiasis, 1093.  
 Intravenous Infusions, Cause and Elimination of Reactions after, 195; Urography, Uroselectan, 761.  
 IRGER, J. M.: Penetrating to the Gasserian Ganglion, 984.  
 Irradiated Ergosterol in the Treatment of Fractures, Non-effect of, 415.  
 IVY, ROBERT: Osteoperiosteal Bone Grafts, 300.
- ### J
- JONES, DANIEL F.: Fractures, Neck of Femur, 895.  
 JOPSON, JOHN H.: Contractile Function of the Gall-bladder, 301; Serum Treatment of Bacteræmia, 910.  
 JOSEPH, BARNET: Insulin in the Treatment of Non-diabetic Bedsores, 318.  
 JUDD, E. STARR: Excision of Duodenal Ulcer, 563.
- ### K
- KELLER, WILLIAM L.: Neurofibroma Pericardial Pleura, 666.  
 KENNEDY, ROBERT H.: Bilateral Subcutaneous Ruptured Quadriceps, 311; Melanocarcinoma of the Arm, 117; Melanocarcinoma of Buccal Mucous Membrane and Upper and Lower Lips, 118; Paget's Disease of the Vulva, 120; Supra-orbital Epithelioma, 115.  
 Kidney Infections, Coccus, 766.  
 KLEIN, REUBEN I.: Brain Calcium in Ether Anæsthesia, 993.  
 KLOPP, EDWARD J.: Removal of Rubber Tube from Common Bile Duct, 1096.  
 Knee-joint Arthrotomy for Hypertrophic Osteoarthritis, 309.  
 Krukenberg Tumors of the Ovary, 149.
- ### L
- LACEY, JAMES T.: Prevention of Peritoneal Adhesions by Amniotic Fluid, 281.  
 LAHEY, FRANK H.: Biliary Fistulæ after Cholecystectomy, 649; Gall-bladder Surgery, 657.  
 LEARMONTH, JAMES R.: Sympathectomy for Hirschsprung's Disease, 710.  
 LEWIS, DEAN: Tumors of Peripheral Nerves, 961.  
 LEWIS, KENNETH M.: Non-effect of Irradiated Ergosterol in the Treatment of Fractures, 415.  
 LEWISOHN, RICHARD: Echinococcus Cyst of Liver, 466; Operative Stricture of the Common Duct, Duodenal Fistula, 467; Recurrent Carcinoma of Sigmoid, Well Two Years after Second Operation, 470; Thrombophlebitic Splenomegaly with Gastric Hæmorrhages, 463.  
 LILIENTHAL, HOWARD: Surgery of Tumors, 671.  
 LIND, SAMUEL C.: Retroperitoneal Fibromyxoma, 1067.  
 Lips, Upper and Lower, Melanocarcinoma of Buccal Mucous Membrane and, 118.  
 Liver, Echinococcus Cyst of the, 461.  
 LORING, MARK: Splanchnic Anæsthesia in Ileus, 721.  
 LOWER, WILLIAM E.: Surgery of Kidneys and Bladder, 765; Vesicovaginal Fistula, 774.  
 Lumbar Sympathectomy, Chronic Arthritis Showing Improvement Following, 306; Sympathetic System, 919.  
 LUND, FRED B.: Fifty Years of the American Surgical Association, Presidential Address at Semicentennial, 481.  
 LYLE, HENRY H. M.: Echinococcus Cyst of the Liver, 462.  
 Lymph Exudate and Fibrous Tissue, 1019.
- ### M
- Malignant Tumors and Their Metastases, 434.  
 MARTIN, HAYES E.: Biopsy by Needle Puncture and Aspiration, 169.  
 MASON, JAMES B.: Desmoid Tumors, 444.

## INDEX

- MATHEWS, FRANK S.:** Aneurism of the Subclavian Artery, 461; Duodenal Fistula: Operative Stricture of the Common Duct, 469; The Surgical Treatment of Urinary Incontinence in Women, 471.
- MATTHIEU, JOSEPH:** Congenital Cyst of Common Bile Duct, 158; Parovarian Dermoid Cyst, 159.
- MAYO, CHARLES H.:** Philosophic Considerations of Gall-bladder, 640.
- MAYO, WILLIAM J.:** Diverticula of the Sigmoid, 739.
- MCCREERY, JOHN A.:** Operative Stricture of the Common Duct: Duodenal Fistula, 470.
- McKENNA, HUGH:** Fractures of Neck of Femur, 882.
- McWHORTER, JOHN E.:** Malignant Tumors and Their Metastases, 434.
- MEADE, RICHARD H., JR.:** Rupture of Primary Bronchus, 154.
- Meckel's Diverticulum, Inflammation of,** 388.
- Mediastinum, Fibrosarcoma of,** 955.
- Melanocarcinoma of the Arm, 117; of Buccal Mucous Membrane and Upper and Lower Lips, 118.**
- Metastasis, Abdominal, of Thyroid Tissue, 1031; Malignant Tumors, 434.**
- MILLER, RICHARD H.:** Acute Cholecystitis, 644.
- MIXTER, W. J.:** Circulatory Disturbances of Extremities, 946.
- MOORHEAD, JOHN J.:** Bilateral Subcutaneous Ruptured Quadriceps, 310; Depressed Fracture of Chest Wall with Hernia of Lung, 312; Knee-joint Arthrotomy for Hypertrophic Osteoarthritis, 309.
- MORTON, JOHN J.:** Circulatory Disturbances of Extremities, 945; Lumbar Sympathetic System, 919.
- Mucous Membrane, Buccal, and Upper and Lower Lips, Melanocarcinoma of, 118.**
- MURRAY, CLAR RAY:** Bilateral Subcutaneous Ruptured Quadriceps, 311.
- Myeloma, Multiple, as a Single Lesion, 425.**
- N**
- Neck of Femur, Fractures of, 882.**
- Necrosis of Bone of Forearm, 1099.**
- Needle Puncture and Aspiration, Biopsy by, 169.**
- Nerves, Tumors of Peripheral, 961.**
- NESBIT, R. M.:** Coccus Infections of the Kidney, 766.
- Neuralgia, Differential Section of Trigeminal Root for, 123.**
- Neurofibroma, Pericardial Pleura, 666.**
- New Orleans, Tetanus in, 1075.**
- New York Surgical Society, 115, 130, 457.**
- NORTH, JOHN PAUL:** The Use of Perfringens Antitoxin in Intestinal Obstruction, 277.
- NYSTROM, GUNNAR:** Operation for Pulmonary Embolism, 498; Surgery of Tumors, 693.
- O**
- Obstruction, Ileocaecal, with Appendicitis, 728.**
- Occlusion, Coronary, Post-operative, 1014.**
- OCHSNER, ALTON:** Röntgen Diagnosis of Ileus, 947.
- Oedema of the Pancreas, Subacute Pancreatitis or So-called Acute, 248.**
- Oesophagus, Plastic Restoration of, 51.**
- Omphalo-enteric Duct, Persisting Obliterated, 1109.**
- "Orr" Method Treatment of Osteomyelitis, 1087.**
- ORR, THOMAS G.:** Post-operative Coronary Occlusion, 1014; Surgery of the Intestines, 709.
- Orthopnoea in Acute Ruptured Tubal Pregnancy, 473.**
- Osteoarthritis, Hypertrophic, Knee-joint Arthrotomy for, 309.**
- Osteochondromatosis, 673.**
- Osteomyelitis, Blastomycetic, of Femur, 1100; of Tibia with Secondary Bone Graft, 313; Treatment of, by "Orr" Method, 1087.**
- Osteoperiosteal Bone Grafts, 161.**
- Ovary, Krukenberg Tumors of the, 149.**
- OVERHOLD, RICHARD H.:** Intraperitoneal Pressure, 302.
- P**
- Paget's Disease of the Vulva, 120.**
- PALMER, BEAN M.:** Post-operative Parotiditis and Radium, 1007.
- Pancreas, Acute Oedema of the, Subacute Pancreatitis, 248.**
- Pancreatitis, Acute Hæmorrhagic, Annular Pancreas Involved in, 241; Subacute, or So-called Acute Oedema of the Pancreas, 248.**



# INDEX

- Papilloma of Common Bile Duct, 658.  
 Parotiditis and Radium, Post-operative, 1007.  
 Parovarian Dermoid Cyst, 159.  
 Pelvic Pain, Chordotomy for Intractable, 335.  
 PEMBERTON, JOHN DE J.: Hyperparathyroidism, 202.  
 Peptic Ulcer, Results of Operations for, 554; Surgery of, 602.  
 Perforations of Stomach and of Duodenum, Consecutive, 308.  
 Perfringens Antitoxin in Intestinal Obstruction, 277.  
 Pericardial Pleura, Neurofibroma of, 666.  
 Peripheral Nerves, Tumors of, 961.  
 Peritoneal Adhesions, Prevention of, by Amniotic Fluid, 281.  
 PETERSEN, WILLIAM F.: Brain Calcium in Ether Anæsthesia, 993.  
 PETREN, GUSTAV: Causes of Post-operative Deaths, 1.  
 PFEIFFER, DAMON B.: Alkalosis Simulating Uræmia, 900; Peritoneal Adhesions, 302.  
 PHEMISTER, DALLAS B.: Surgery of Tumors, 679.  
 Philadelphia Academy of Surgery, Transactions of, 300, 302, 1093, 1099.  
 Pleura, Neurofibroma Pericardial, 666.  
 PORTER, MILES F.: Surgery of Tumors, 672.  
 Post-operative Deaths, Causes of, 1.  
 POTTS, WILLIS J.: Chemical Obliteration of Varicose Veins, 475.  
 Prostatectomy, Primary Closure in, 82.  
 Pulmonary, Atelectasis, Post-operative, 801; Embolism, Operation for, 498.  
 Pyloric, Occlusion, Sulphuric Acid, 897; Sphincter, Partial Resection of, 533.
- Q**
- Quadriceps, Bilateral Subcutaneous Rupture of, 310.
- R**
- RADEMAKER, LEE A.: Bacteriophage, 1105; Cause and Elimination of Reactions after Intravenous Infusions, 195.  
 Radium and Parotiditis, Post-operative, 1007.  
 RAINE, FORRESTER: A Dependable Method for Suturing Stomach and Intestines, 410.  
 RANDALL, OSMER S.: Post-operative Coronary Occlusion, 1014.  
 RANKIN, FRED W.: Post-operative Parotiditis and Radium, 1007; Sympathectomy for Hirschsprung's Disease, 710.  
 Rat-bite Fever, 316.  
 RAVDIN, ISIDOR S.: Contractile Function of the Gall-bladder, 301.  
 Reconstruction of Anal Sphincter, 152.  
 Rectum, Carcinoma of, 309.  
 Rehfuß Tube in Gastric Surgery, 1114.  
 Resection, Posterior, of Upper Three Ribs, Muscle-splitting Incision for, 1107.  
 Retroperitoneal Fibromyxoma, 1067.  
 REUTERSKIOLD, KNUTE: Post-operative Blood Chemistry, 786.  
 Ribs, Muscle-splitting Incision for Posterior Resection of Upper Three, 1107.  
 RICE, CARL O.: Imperforate Anus, 77.  
 RIXFORD, EMMET: Osteochondromatosis, 673.  
 ROBERTSON, D. E.: Surgery of the Intestines, 726.  
 Röntgen Diagnosis of Ileus, 947.  
 ROSENTHAL, NATHAN: Thrombophlebitic Splenomegaly, 465.  
 ROYSTER, HUBERT A.: Surgery of the Intestines, 738.  
 Rubber Tube, Removal of, from Common Bile Duct, 1096.  
 Rupture of Primary Bronchus, 154.
- S**
- ST. JOHN, FORDYCE B.: Surgical Therapy for Gastric and Duodenal Ulcer, 597.  
 SALVIN, ARTHUR A.: Ectopic Spleen Causing Intestinal Obstruction, 263.  
 SANDERS, ROBERT L.: End-results in 500 Cases of Cholecystectomy, 376.  
 Sarcoma of Breast, 1059.  
 SAUNDERS, EDWARD WATTS: A Bacteriological and Clinical Study of Gastric Ulcer, 222.  
 SCHLEY, WINFIELD SCOTT: Bowel Carcinoma, 130.  
 SCHWYZER, ARNOLD: Long-lasting Post-operative Benefit of Cancer of Stomach, 540.  
 SCOTT, W. J. MERLE: Lumbar Sympathetic System, 919; Surgery of the Intestines, 727.  
 Serum Treatment of Bacteræmia, 910.  
 SHALLOW, THOMAS A.: Traumatic Lesions of the Brachial Plexus, 182.



# INDEX

- SHAPIRO, PHILLIP F.: Abdominal Metastasis of Thyroid Tissue, 1031.
- SHERWOOD, WALTER A.: Echinococcus Cyst of the Liver, 462.
- SHORE, BENJAMIN RICE: Acute Ulcerations of the Stomach in Children, 234.
- Sigmoid, Diverticula of the, 739; Recurrent Carcinoma of, 470.
- SIMMONS, CHANNING C.: Cancer of the Buccal Mucosa, 681.
- Sinuses and Thyroglossal Cysts, 57.
- SISE, LINCOLN F.: Sodium Iso-amylethyl Barbiturate and Spinal Anæsthesia, 472.
- Skin Ulceration, Post-operative Progressive, 779.
- Sliding Hernias, Anatomy and Operative Technique of, 754.
- SMITH, MORRIS K.: Surgical Treatment of Urinary Incontinence in Women, 394, 471.
- SMYTH, CALVIN M.: Open Fracture of Leg, 1105.
- SPEED, KELLOGG: Fractures, Neck of Femur, 894.
- SPEESE, JOHN: Ileocaecal Obstruction with Appendicitis, 728.
- Spermatic Cord in Infancy, Torsion of the, 405.
- Sphincter, Anal, Reconstruction of, 152; Pyloric, Partial Resection of, 533.
- SPIEGEL, L.: Insulin in the Treatment of Non-diabetic Bedsores, 318.
- Spinal Cord, Tumor of the, 122.
- Splanchnic Anæsthesia in Ileus, 721.
- Spleen, Cysts of the, 67; Ectopic, Causing Intestinal Obstruction, 263.
- Splenomegaly, Thrombophlebitic, with Gastric Hæmorrhages, 463.
- Steel Skewers, Immobilization by, in Fractures, 147.
- STETTEN, DEWITT: Subacute Pancreatitis or So-called Acute Edema of the Pancreas, 248.
- Stomach Cancer, Long-lasting Post-operative Benefit, 540; Operative Results for, 574.
- Stomach and Duodenum, Consecutive Perforations of, 308; Deformities and Obstructions of the, 367.
- Stomach in Children, Acute Ulcerations of the, 234.
- Stomach and Intestines, Suturing, a Dependable Method for, 410.
- STOOKEY, BYRON: Cholesteatoma, 123; Differential Section of Trigeminal Root for Neuralgia, 123; Facial-hypoglossal Nerve Crossing, 122; Tumor of the Spinal Cord, 122.
- Stricture, Operative, of the Common Bile Duct: Duodenal Fistula, 467.
- STUEBNER, ROLAND W.: Rehfuß Tube in Gastric Surgery, 1114.
- Subclavian Artery, Aneurism of the, 458.
- Subphrenic Abscess, Transpleural, Operation for, 477.
- SULLIVAN, DANIEL F.: Intestinal Obstruction, 270.
- Sulphuric Acid Pyloric Occlusion, 897.
- Supra-orbital Epithelioma, 115.
- SUTTON, JOHN E., JR.: Intrahepatic Bile-duct Changes, 141.
- Suturing Stomach and Intestines, A Dependable Method for, 410.
- SWARTLEY, WILLIAM B.: Intrahepatic Cholelithiasis, 1093.
- SWEET, J. EDWIN: Gastric Ulcer, 304.
- Sympathectomy, for Hirschsprung's Disease, 710; Lumbar, Chronic Arthritis Showing Improvement Following, 306.
- Sympathetic System, Lumbar, 919.
- Synovial Membrane, Intra-articular Endothelial Tumors Arising from, 421.
- ## T
- Tendon Strips in Facial Paralysis, 694.
- Tetanus in New Orleans, 1075.
- THALHIMER, WILLIAM: A Dependable Method for Suturing Stomach and Intestines, 410.
- Thoracic, Acute Empyema, Treatment of, 212.
- Thorax, Tumors of Wall of, 1043.
- Thrombophlebitic Splenomegaly with Gastric Hæmorrhages, 463.
- Thyroglossal Cysts and Sinuses, 57.
- Thyroid Tissue, Abdominal Metastasis of, 1031.
- TINKER, MARTIN B.: Surgery of Tumors, 692.
- Torsion of the Spermatic Cord in Infancy, 405.
- Transpleural Operation for Subphrenic Abscess, 477.
- Traumatic Lesions of the Brachial Plexus, 182.
- Trigeminal Root for Neuralgia, Differential Section of, 123.

# INDEX

Tubal Pregnancy, Orthopnoea in Acute Ruptured, 473.  
 Tumors, Desmoid, 444; Endothelial, Intra-articular, Arising from Synovial Membrane, 421; Krukenberg, of the Ovary, 149; Malignant, and Their Metastases, 434; of Peripheral Nerves, 961; of the Spinal Cord, 122; of the Wall of the Thorax, 1043.

## U

Ulcer, Duodenal, Excision of, 563; Duodenal, Operative Mortality, 616; Duodenal, Operative Results, 620; Gastric, a Bacteriological and Clinical Study of, 222; Gastric and Duodenal, Mortality and Late Results of Subtotal Gastrectomy for the Radical Cure of, 340; Gastro-enterostomy for, Results of, 558; Peptic, Results of Operations for, 554; Peptic, Surgery of, 602.  
 Ulceration, Post-operative Progressive Skin, 779; of the Stomach in Children, Acute, 234.  
 Umbilical Cord (Exomphalos), Hernia of the, 454.  
 Uræmia, Alkalosis Simulating, 900.  
 Urinary, Incontinence in Women, Surgical Treatment of, 394; Tract in Children, Diseases of the, Review of Beer and Hyman on, 320.  
 Uroselectan Intravenous Urography, 761.

## V

VAN ALSTYNE, GUY S.: Persisting Obliterated Omphalo-enteric Duct, 1109.  
 VANDER VEER, ALBERT: Memoir of, 1119.  
 Varicose Veins, Chemical Obliteration of, 475.  
 VAUGHN, JOHN WALTER: Entero-anastomosis in Ileus, 704.  
 VEAL, J. R.: Foreign Body in Heart, 1097.

Vesical Neck Obstruction, Posterior, Pathological Study of, 294.  
 Vesicovaginal Fistula, 774.  
 Vulva, Paget's Disease of the, 120.

## W

WAGNER, LEWIS CLARK: Intra-articular Endothelial Tumors Arising from Synovial Membrane, 421.  
 WAGONER, GEORGE: Osteoperiosteal Bone Grafts, 300.  
 Wall of Thorax, Tumors of Wall of, 1043.  
 WANGENSTEEN, OWEN H.: Imperforate Anus, 77.  
 WATERWORTH, SAMUEL J.: Immobilization by Steel Skewers in Fractures, 147.  
 WEBB, ROSCOE C.: Fracture of Neck of Femur in Nonagenarian, 1112.  
 Welch Bacillus Antitoxin in Intestinal Obstruction, 301.  
 WHEELER, JOHN M.: Pulsating Exophthalmos, 8.  
 WHITE, WILLIAM CRAWFORD: Osteomyelitis of Tibia with Bone Graft, 313; Rat-bite Fever, 316.  
 WILLARD, DeFORREST: "Orr" Method of Treatment of Osteomyelitis, 1105.  
 WOLFSON, WILLIAM L.: Inflammation of Meckel's Diverticulum, 388.  
 Women, Surgical Treatment of Urinary Incontinence in, 386.  
 WRIGHT, ROY W.: Sarcoma of Breast, 1059.

## Y

YATES, JOHN L.: A Dependable Method for Suturing Stomach and Intestines, 410.  
 YOUNG, ARCHIBALD: Open Operation in Fractures, 838.

## Z

ZINNINGER, M. M.: Tumors of Wall of Thorax, 1043.



# THE ALEXANDER FUND

## Ninety-fourth Quarterly Distribution Issue of New Series

The Fund was started in the Spring of 1907 after a severe market decline (compare with the Spring of 1930). In November 1907 Series C was issued at what proved to be about the low point of the panic (consider this under present November conditions). Series C began dividends at the rate of 10 per cent per annum, and after a short life was withdrawn at \$182.92 per \$100.00 share. The Fund is now issuing Series XX. Shares \$100.00 each. Subscription list will remain open until November 15th. Shares may be subscribed to or withdrawn at any time at market value.

The 94th quarterly distribution was made on November 1st at rates ranging from 6 per cent to 16 per cent per annum.

Assets . . . . . \$2,900,000.00

Apply for Booklet A. S.

Room 1228 Land Title Building

Philadelphia, Pa.

## Valentine's Meat-Juice

In Gastric and Intestinal Troubles, in Febrile Conditions, and before and after Surgical Operations when the Stomach is Rejecting Food, Valentine's Meat-Juice demonstrates its Ease of Assimilation and Power to Restore and Strengthen.

### In Hospital Practice

P. McDonnell, M. B. Hon. Surgeon, Lowestoft and North Suffolk Hospital, Lowestoft, England: "We have found VALENTINE'S MEAT-JUICE invaluable in cases of shock and collapse of men who have been blown up in their ships by mines and torpedoes. Some of the patients have been severely injured, often for hours before admission here, and VALENTINE'S MEAT-JUICE has been the only food they could retain."

Dr. E. Duloxy, Physician Accoucher to the International Hospital, Paris, France: "A young accouchée, in a very weak condition and suffering from stomach trouble, could retain no food, but was able to assimilate VALENTINE'S MEAT-JUICE given at first in small doses. An improvement was quickly visible, the patient recovered her strength and is to-day in good health."

For sale by American and European Chemists and Druggists.

**VALENTINE'S MEAT-JUICE COMPANY**

Richmond, Virginia, U. S. A.





# What about taste?

Do you have to apologize for the taste of the medicines you prescribe? Or do your patients still believe innocently that the medicine must be bitter to be efficacious?

Agarol, the original mineral oil and agar-agar emulsion with phenolphthalein, is for that up-to-date generation that wants its medicines in the proverbial "sugar coating."

No excuses are needed for its taste any more than for its effectiveness. Agarol is exceptionally palatable without artificial flavoring. It flows freely from the bottle, and can be mixed with any liquid or soft food.

Just enough mineral oil to carry unabsorbable moisture to the intestinal contents, keep them soft, and so make evacuation easy and painless. By gentle stimulation of peristalsis, Agarol makes the result certain, and aids in re-establishing regular habits.

*One tablespoonful at bedtime—is the dose*

Final decision on the true worth of Agarol rests with the physician. We will gladly send a twin package, with literature, for trial.

## AGAROL *for Constipation*

WILLIAM R. WARNER & COMPANY, Inc., 113 W. 18th Street, New York City

### NEW YORK POST-GRADUATE MEDICAL SCHOOL AND HOSPITAL

*offers courses in*

#### ROENTGENOLOGY

A basic course of six weeks in the principles and practice of roentgenology is followed by an advanced course of six weeks in plate interpretation, fluoroscopy, and therapy. Admission to the advanced course is granted to those who have completed the basic course, or who have had at least 5 years' experience in roentgenology.

Further instruction in roentgenology may be individually arranged for on completion of the three months' work.

Under the direction of DR. WILLIAM H. MEYER

Licensed physicians in good standing are admitted to these courses.

The next basic course begins January 5, 1931; the next advanced course begins February 16, 1931.

*For descriptive booklet and further information, address*

**The Dean, 302 East 21st Street, New York City**



on

City

5